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Abey, A.E., Apparatus for deformation tests at intermediate strain rates—10^{-2} to 10^{-2} s^{-1}—and at high pressure. 3:1118 (UCRL-79012)
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ENERGY RESEARCH ABSTRACTS

COAL AND COAL PRODUCTS

REFER ALSO TO CITATION(S) 953, 1016

PROCESSING

REFER ALSO TO CITATION(S) 577, 1034

1 (CONF-760838—, pp 21p, Paper 10) **New concept for the manufacture of low sulfur fuels and chemicals from coal.** Udani, L.H. (Catalytic, Inc., Philadelphia); Maddocks, R.R.; Stokes, C.A. 1976.

From 3. annual international conference on coal gasification and liquefaction; Pittsburgh, Pennsylvania, United States of America (USA) (3 Aug 1976).

In 3rd international conference on coal gasification and liquefaction.

The process visualized begins with run-of-the-mine coal which is prepared and hydroliquefied in the usual fashion as in the SRC process. The reaction mixture is flashed to remove excess hydrogen and other vapors and gases. Hydrogen and hydrocarbon gases are recovered after gas clean up and recycled or used as plant fuel. The flashed liquid is further stripped to remove a light oil fraction and some solvent. The light distillates are also used as clean plant fuel. The stripped bottoms are treated in a solvent de-ashing unit. The overflow is 70% of the charge and is essentially solid-free product. It is fractionated to separate the de-ashing solvent and process solvent from the SRC product. Syn-gas from solids formed in the process would be the source of hydrogen for the SRC process and ammonia synthesis. Co-products from the gas plant would be elemental sulfur, phenolics, CO_2 and slag. The product slate of such a coal processing plant would include SRC, low BTU fuel gas, heavy and light distillates, and ammonia. The SRC product would be used as a premium utility fuel or as a feed stock for needle or anode coke. It can also be converted to binder's pitch. Uses for ammonia are legion.

2 (CONF-760838—, pp 26p, Paper 15) **Implications of utilizing synthetic fuels in combined cycles.** Ahner, D.J. (General Electric Co., Schenectady, NY). 1976.

From 3. annual international conference on coal gasification and liquefaction; Pittsburgh, Pennsylvania, United States of America (USA) (3 Aug 1976).

In 3rd international conference on coal gasification and liquefaction.

The characteristics of the fuel to be handled, combusted and expanded in gas turbine cycles has a major influence from the standpoint of equipment reliability, environmental performance, efficiency, and economics. These characteristics effect the basic component design approach, materials selection, selection of the thermodynamic cycle, and the operating conditions, and thus performance levels which may be achieved in the basic gas turbine and correspondingly in the combined cycle. The discussion indicates the potential of the combined cycle and how the prospect of utilizing coal or coal-derived fuels impact some of the basic considerations in the equipment configuration, design and performance.

CARBONIZATION

REFER ALSO TO CITATION(S) 41

3 (FE—1220-26) **Clean Coke Process: process development studies. Monthly report, May 1977.** Jun 1977. Contract EX-76-C-01-1220. 13p. Dep. NTIS, PC A02/MF A01.

West Kentucky coal was successfully processed through both stages of carbonization, at 820 and 1400°F. The char produced contained 0.99% sulfur. Maintenance work on the flash vaporizer of the binder-preparation PDU was completed, and the unit was operated to process liquid blowdown from the carbonization PDU. The clean wash oil recovered amounted to 1870 pounds. This wash oil was then processed in the batch distillation column where 90% of the naphthalene was removed. In the hydrogenation area, Clairton heavy creosote was catalytically hydrogenated for use as a flux with SRC product to prepare binder for cokemaking. The Andreas Hofer hydrogen-makeup compressor was reinstalled in the hydrogenation PDU after extensive repairs. Green pellets produced previously in the coke-preparation PDU were calcined; the coke pellets exhibited satisfactory strength and hardness. The pellets had been made from process char and a binder of SRC product fluxed with SRC solvent oil.

DESULFURIZATION AND PURIFICATION

REFER ALSO TO CITATION(S) 18, 61

4 (CONF-760838—, pp 7p, Paper 4) **Applicability of the Meyers process for desulfurization of U.S. coal. A survey of 35 coal mines.** Meyers, R.A.; Hamersma, J.W. (TRW Systems and Energy, Redondo Beach, CA). 1976.

From 3. annual international conference on coal gasification and liquefaction; Pittsburgh, Pennsylvania, United States of America (USA) (3 Aug 1976).

In 3rd international conference on coal gasification and liquefaction.

The Meyers Process utilizes a regenerable aqueous ferric sulfate leaching unit to chemically convert and remove the pyritic sulfur content of coal as elemental sulfur and iron sulfate. In addition, the ash content of the coal is decreased by 10 to 50 percent and as a result the heat content per unit weight increases by as much as 13%. In this process, aqueous ferric sulfate (a mild but effective oxidizing agent) selectively oxidizes the pyritic sulfur content of coal to form free sulfur and sulfate. Iron sulfate dissolves in the aqueous solution. The free sulfur may then be removed from the coal matrix by vaporization or solvent extraction and the oxidizing agent may be regenerated and recycled by reaction with air or oxygen. The detailed chemistry, reaction kinetics and process engineering and cost estimates have been published and a test plant is being built. This paper presents a discussion and experimental results directed to the applicability of the process for meeting pollution control standards by desulfurization of raw run-of-mine coal. In the production of clean fuel using commercial practices, it is very likely that an optimum process cost and product will be obtained by physically cleaning coal prior to ferric sulfate leaching, in order to remove rock and some of the larger pyrite particles. There are preliminary indications that the efficiency of the Meyers Process may be enchanced by utilization of physically cleaned coal, resulting in faster rates, greater total removal, and reduced ash dissolution.

5 (CONF-760838—, pp 6p, Paper 8) **Meyers process: plant design, economics and energy balance.** van Nice, L.J.; Santy, M.J.; Meyers, R.A. (TRW Systems and Energy, Redondo Beach, CA). 1976.

From 3. annual international conference on coal gasification and liquefaction; Pittsburgh, Pennsylvania, United States of America (USA) (3 Aug 1976).

In 3rd international conference on coal gasification and liquefaction.

Coal can be desulfurized prior to combustion using the Meyers Process to meet governmental requirements for sulfur oxide emissions. The physical form of the coal remains unchanged, only sulfur and some inorganic materials are removed. The process re-

moves up to 80 percent of the total sulfur content of coal through chemical leaching of 90 to 95 percent of the pyritic sulfur contained in the coal matrix with aqueous ferric sulfate solutions at temperatures of 90 to 130°C. The process consists of several steps including crushing, chemical treating, sulfur removal and solution regeneration. The process applies primarily to coals rich in pyritic sulfur rather than those with mainly organic sulfur.

HYDROGENATION

REFER ALSO TO CITATION(S) 3, 41, 44, 45, 46

GASIFICATION

REFER ALSO TO CITATION(S) 41, 68, 92, 107, 370, 397, 1046, 1047, 1048

6 (ANL/MSD/FE—77-1) **Synthane gasifier distributor cone thermocouple sheath (TE-268) failures: failure analysis report.** Danyluk, S.; Dragel, G.M. Oct 1976. Contract W-31-109-ENG-38. 43p. Dep. NTIS, PC A03/MF A01.

The results of the failure analysis of the gasifier distributor cone thermocouple sheaths (TE-268) from the Synthane high Btu conversion pilot plant are presented. The thermocouples are used to monitor the distributor cone temperature, and the sheaths housing the thermocouples are normally exposed to a steam and oxygen environment (600 psig and 650°F) in the plenum below the cone. The failures of the sheathing material (Incoloy 800) are associated with sulfur-related corrosion cracks and plastic deformation and tearing, due in part to expansion of the MgO insulating material. A combination of corrosive environment, off-process temperatures, methods used in fabrication, and possible cold working contributed to the failures.

7 (ANL/MSD/FE—77-2) **Synthane weld neck flange failure: failure analysis report.** Danyluk, S.; Dragel, G.M. Nov 1976. Contract W-31-109-ENG-38. 21p. Dep. NTIS, PC A02/MF A01.

The Synthane high-Btu coal-conversion pilot plant was shut down following the discovery of a leaking crack in a Type 304 stainless steel weld neck flange that is part of a preheat line of the gasifier. The flange was exposed to approximately 2.9 Ms (approximately 800 h) of operation at 4.3 MPa (600 psig) steam at 399°C (750°F). Several additional nonleaking intergranular cracks were also found at the inside diameter surface of the weld neck. The cracks are believed to be due to intergranular stress corrosion. Also, the heat-affected zone near the weld and/or chlorides may have contributed to the cracking. Metallography revealed that slip and precipitation on slip planes and grain boundaries had occurred. This suggests that the region of the flange near the leak had undergone considerable plastic deformation prior to a heat treatment.

8 (ANL/MSD/FE—77-3) **Analysis of the HYGAS ash-agglomerating gasifier internal cyclone dipleg failure: failure analysis report.** Danyluk, S.; Greenburg, S. Dec 1976. Contract W-31-109-ENG-38. 19p. Dep. NTIS, PC A02/MF A01.

The results of the analysis of the Ash-agglomerating Gasifier (AAG) internal cyclone dipleg from the HYGAS pilot plant are summarized. The dipleg is attached to the cyclone, which removes particulate matter from the hot produce gases and recycles it through the gasifier. A flapper valve at the bottom of the dipleg is closed to permit half of the dipleg to fill with pulverized particulates. During normal operation, the dipleg is exposed to a steam and oxygen environment with temperatures near the bed temperature of 1038°C. The failure of the dipleg, fabricated of Incoloy 800, is believed to be associated with sulfidation and carburization coupled with high-temperature (off-process) operation.

9 (CONF-760838—) **3rd international conference on coal gasification and liquefaction.** 1976. vp. of Pittsburgh, PA $50/set.

From 3. annual international conference on coal gasification and liquefaction; Pittsburgh, Pennsylvania, United States of America (USA) (3 Aug 1976).

The third annual international conference on "Coal Gasification and Liquefaction: What Needs to be Done Now" was held at the University of Pittsburgh, Pittsburgh, PA on August 3-5, 1976. The majority of the papers dealt with coal gasification and liquefaction (often on the basis of process pilot plant experience) and on flue gas desulfurization by a variety of processes; fewer papers involved fluidized bed combustion, combined cycle power plants, coal desulfurization, government policy on environmental effects and on synthetic fuels, etc. Twenty-eight papers have been entered individually into EDB and ERA. (LTN)

10 (CONF-760838—, pp 13p, Paper 1) **Applications of the Woodall—Duckham two stage coal gasification.** Grant, A.J. (Woodall—Duckham Ltd., Pittsburgh). 1976.

From 3. annual international conference on coal gasification and liquefaction; Pittsburgh, Pennsylvania, United States of America (USA) (3 Aug 1976).

In 3rd international conference on coal gasification and liquefaction.

The principle of Woodall-Duckham two-stage coal gasification is to separate the volatile matter of the coal before subjecting the remainder of the coal to the high temperatures of the gasification reactions. Coal entering the top of the gasifier meets top gas which leaves the gasifier at about 250°F. As it descends, the coal is dried, then evolves gas, light hydrocarbons and tar, and reaches the bottom of the upper part of the gasifier as semi-coke, or char if the coal is a non-agglomerating coal such as sub-bituminous or lignite. The semi-coke or char passes into the gasification zone, where temperatures rise from about 1200°F at the side gas off-take to typically 2200°F at the final combustion stage. The gasification agent (air—steam or oxygen—air—steam) converts the semi-coke into carbon monoxide, carbon dioxide, hydrogen, some undecomposed steam and nitrogen. The sensible heat of this gas at about 1200°F is roughly double that required to dry and distill the volatile matter from the incoming coal. Therefore about half the clear gas is withdrawn at 1200°F, via the side gas offtake. Due to the low gas off-take velocity there is little carryover of coal fines. Since the coal hydrocarbons are removed at relatively low temperature before gasification they are not significantly cracked.

11 (CONF-760838—, pp 16p, Paper 14) **Dilute-phase hydrogasification process for SNG production.** Chambers, H.F. Jr.; Mima, J.A.; Yavorsky, P.M. 1976.

From 3. annual international conference on coal gasification and liquefaction; Pittsburgh, Pennsylvania, United States of America (USA) (3 Aug 1976).

In 3rd international conference on coal gasification and liquefaction.

Hydrogasification is the name given to the conversion of coal to methane by direct reaction with hydrogen as opposed to methanation of synthesis gas. In the DPH process, raw coal is fed directly to the reactor so that the particles free-fall in a dilute cloud through the hydrogen atmosphere. During free-fall particles are heated very rapidly forming a nonagglomerating and highly reactive char, thus eliminating the requirement for coal pretreatment. Since it is estimated that 9% of the volatile matter and 13% of the coal weight may be lost in pretreatment, this approach will result in decreased hydrogen and coal requirements in SNG production. Another attractive feature of the process is that nominally 90% of the methane product is produced directly in the reactor, requiring only a light methanation step to remove the approximately 3% CO remaining in the effluent gas.

12 (CONF-760838—, pp 20p, Paper 18) **Current status of the BI-GAS processing.** (Univ. of Pittsburgh). 1976.

From 3. annual international conference on coal gasification and liquefaction; Pittsburgh, Pennsylvania, United States of America (USA) (3 Aug 1976).

In 3rd international conference on coal gasification and liquefaction.

In early 1970, BCR initiated a program to develop kinetic data on methanation catalysts that might be used for developmental gasification processes. Bench-scale experimental units were designed to study conversion of synthesis gas to methane at 1000-5000 psi and at temperatures between 600 and 1000 F. Experimental work progressed quite satisfactorily, and it became apparent that the fluidized-bed methanation system should be investigated on a larger scale in order to provide more meaningful data for pilot plant operations. Emphasis was placed on providing operational flexibility to permit study of key variables in the production of pipeline-quality gas. PEDU tests began in early 1974 and have continued until the present time, obtaining operating data on selected catalysts and exploring such variables as feed gas composition, pressure, bed temperature, and space velocity. The current experimental program is directed toward optimization of operating conditions for the pilot plant methanator. While BCR's main efforts have been in the areas of entrained gasification, and development of the fluidized-bed methanation concept, the pilot plant contains all equipment necessary for complete handling and processing of coal and product gases.

13 (CONF-760838—, pp 12p, Paper 21) **Synthane process: current status.** Haynes, W.P.; Strakey, J.P.; Lewis, R. (Energy Research and Development Administration, Pittsburgh). 1976.

From 3. annual international conference on coal gasification and liquefaction; Pittsburgh, Pennsylvania, United States of America (USA) (3 Aug 1976).

In 3rd international conference on coal gasification and liquefaction.

Shakedown and orientation tests have been completed on the gasifier section of the 72 ton per day SYNTHANE pilot plant. Initial gasification tests with Rosebud subbituminous coal have been started. Thus far, no major process problems have been encountered. Mechanical malfunctions, however, involving equipment and instru-

mentation, have resulted in operating periods of short duration. Improved equipment and instrumentation more suitable for coal gasification systems should be developed. During the initial operating periods, the gasifier has been responsive and easy to control. To demonstrate the potential of the synthane gasifier to achieve a high on-stream factor because of its simplicity, the development test program calls for relatively long operating campaigns of up to 4 weeks duration. Significant support projects are in progress and include the fields of water treatment, valve development, and hot char discharge. The results from these projects should be of great value to developers of other coal conversion processes.

14 (CONF-760838—, pp 39p, Paper 22) **Koppers—Totzek economics and inflation.** Mitsak, D.M.; Michaels, H.J.; Kamody, J.F. (Koppers Co., Inc., Pittsburgh). 1976.

From 3. annual international conference on coal gasification and liquefaction; Pittsburgh, Pennsylvania, United States of America (USA) (3 Aug 1976).

In 3rd international conference on coal gasification and liquefaction.

The implication of the calculations is that, although the present cost of gas produced via K-T gasification may be more expensive than other fuels available today, the effects of inflation and increased prices of natural gas and oil due to diminishing supplies and higher exploratory and development costs, can be such that over a relatively short period of time, the cost of energy from existing K-T gasification facilities will be less than that of alternate sources. It is important to realize that the portion of the cost of synthetic fuel that is associated with the return of interest and principal to the creditors of the project is not generally subject to escalation. Operating costs are subject to inflation but will not increase the cost of gas by nearly the amount of their increase. Therefore, a prudent manager and/or decision maker will apply the above types of analyses, using his particular values for parameters such as the cost of capital, to arrive at a decision whether K-T gasification or the purchase of an alternate fuel such as No. 2 fuel oil is the economic choice for the future.

15 (CONF-760838—, pp 9p, Paper 23) **Riley—Morgan gasifier.** Walsh, T.F. (Riley Stoker Corp., Worcester, MA). 1976.

From 3. annual international conference on coal gasification and liquefaction; Pittsburgh, Pennsylvania, United States of America (USA) (3 Aug 1976).

In 3rd international conference on coal gasification and liquefaction.

The Riley Stoker Corporation has purchased the rights to the old Morgan fixed-bed gasifier. More than 9000 of these Morgan units were sold in the early 1900's as small gasifiers for industrial plants. The equipment has been redesigned for modern manufacturing processes, higher operating pressure, automatic control and low health hazard due to gases and dusts. It can produce a gas of 300 Btu/cu. ft. with anthracite or low-sulfur bituminous coal. The equipment can be adapted to coking or high-sulfur bituminous coal; however, due to the added cost of tar and sulfur cleanup and of the oxygen equipment, relatively large installations with high load factors are required for economical gas production. The new equipment has undergone extensive testing with various types of coal. (LTN)

16 (CONF-760838—, pp 13p, Paper 24) **HYGAS process update.** Vorres, K.S. (Inst. of Gas Tech., Chicago). 1976.

From 3. annual international conference on coal gasification and liquefaction; Pittsburgh, Pennsylvania, United States of America (USA) (3 Aug 1976).

In 3rd international conference on coal gasification and liquefaction.

The HYGAS program has demonstrated the key process concepts and integrated unit operations involved in the production of substitute natural gas. It has also demonstrated several methods of hydrogen generation, including catalytic steam reforming of natural gas, electrothermal gasification, and also steam-oxygen gasification. A total of 37 tests conducted with lignite, involving 5500 tons of lignite processed, demonstrated the technical feasibility of a gasification process using lignite. A total of 17 tests were conducted with 3100 tons of bituminous coal. Some specific objectives of the HYGAS program for fiscal 1977 include tests to be conducted with subbituminous coal. Data will be collected for use in the design of an effluent treatment and water reuse cycle in a commercial plant. New methanation catalysts will be tested. Materials testing will continue.

17 (CONF-760838—, pp 19p, Paper 28) **Political and economic justification for immediate realization of a Syn fuels industry.** Gallagher, J.T. 1976.

From 3. annual international conference on coal gasification and liquefaction; Pittsburgh, Pennsylvania, United States of America (USA) (3 Aug 1976).

In 3rd international conference on coal gasification and liquefaction.

The conclusions that can be drawn from these analyses are that coal gasification produces a gas which is unavoidably more expensive than indigenous natural gas at the present price level, and that new processes when they are ready to go commercial will not significantly reduce the cost for gas-from-coal. In fact, the inflation rate will easily eliminate all savings which might result from the successful development of new processes. Since the initial first effort in 1936, our commercial exerience has helped us to refine the LURGI process. Our expanded chemical and mechanical engineering know-how influenced the design of many individual components, all of which culminated in the design of the present total process plant. There has been tremendous progress in the technology. However, in order to continue to build on this progress and to seek other improvements in a logical way, it is vital that commercial plants be built, based on the status of today's technology. The LURGI coal gasification process comprises much more than just the gasifier. It includes all process steps necessary to produce gas of the required quality. As with the evolution of today's modern gasifier, the remainder of the process has undergone a major transformation from the initial town gas plants built many years ago. These improvements are discussed briefly.

18 (ERDA—76-93/4) **Coal gasification. Quarterly report, October—December 1976.** 1976. 80p. Dep. NTIS, PC A05/MF A01.

In addition to an executive summary and glossary, the following sections are included: Carbon Dioxide Acceptor Coal Gasification Process; Bi-gas Process for the Generation of Pipeline Gas; Pipeline Gas by Hydrogasification (Hygas Process); Steam-Iron System for Production of Hydrogen; Synthane Process; Agglomerating Burner Process; Liquid Phase Methanation Process; Evaluation of High-Btu Gasification Projects; Molten Salt Gasification Process; Advanced Coal Gasification System for Electric Power Generation; Low-Btu Gasification of Coal for Electricity Generation; Coal Gasification Combined-cycle System for Electric Power Generation; Low-Btu Fuel Gas; Desulfurization of Low-Btu Producer Gas; The Coal Conversion Systems Technical Data Book; Computer Modeling of Coal Gasification Reactors; and Modification and Operation of an Atmospheric Pressure Ash-Agglomerating Gasifier. (EJH)

19 (ERDA—76-96/4) **Coal demonstration plants. Quarterly report, October—December 1976.** 1976. 49p. Dep. NTIS, PC A03/MF A01.

In addition to an executive summary and glossary, the following sections are included: Clean Boiler Fuel Demonstration Plant; Development of Coal Feeders for Coal Gasification Operations; Development of a Continuous Dry Coal Screw Feeder; Coal Feeder Development Program; Engineering and Technical Support; Technical Assistance Services; and Conceptual Design for an Advanced Coal Liquefaction Commercial Plant. (EJH)

20 (FE—1513-63) **Agglomerating burner gasification process: design, installation, and operation of a 25-ton-a-day process development unit. Monthly progress report, July 1977.** 8 Aug 1977. Contract EX-76-C-01-1513. 13p. Dep. NTIS, PC A02/MF A01.

This monthly report summarizes progress on the operation of the 25-ton-a-day coal gasification PDU to study the Agglomerating Burner Gasification Process. Also reported is work on the process engineering task and the activity on the turbine engineering study. Continued spalling of the refractory lining in the burner and gasifier vessels, and consequent plugging of the solids circulation loops, has negated attempts to complete an integrated gasification run. The vessels will need to be relined; however, we believe every prudent attempt should be made to demonstrate the technical feasibility of the process before undertaking this extensive maintenance. As a temporary expediency, stainless steel liners have been installed in the vessels. It is hoped that these liners will maintain their structural integrity and exclude the refractory spalls from the system for a sufficient time to permit an integrated run. Fabrication of the erosion test rig is complete and the unit is nearly ready for hot-gas calibration. Erosion pin specimens have been ordered.

21 (FE—1514-70) **Advanced coal gasification system for electric power generation. Sixtieth monthly progress report, July 1977.** Keairns, D.L.; Salvador, L.A. 16 Aug 1977. Contract EX-76-C-01-1514. 10p. Dep. NTIS, PC A02/MF A01.

Gasifier air tube evaluation tests with coke breeze continued in July. Test conditions in the reactor system for the first steady-state test point are given. Much of the engineering design work related to hardware modifications for integrating the two reactors is approaching completion. PDU maintenance, construction, and operation are described. Laboratory support studies included combustor-gasifier test program support; the devolatilizer; coal behavior; ash behavior; sorbent behavior; and reactor analysis.

22 (FE—2210-18) **Study of heat transfer through refractory lined gasifier vessel walls. Monthly technical progress report, July 1977.** Schorr, J.R. Aug 1977. Contract EX-76-C-01-2210. 8p. Dep. NTIS, PC A02/MF A01.

This is the fifteenth month of a 22-month study to evaluate heat transfer through refractory-lined coal gasification vessel walls. The objectives of this program include development of an empirically derived computer model suitable for determining the heat flow

through complex, multicomponent refractory linings, such that the effect of lining thickness, density, composition, anchors, gases, and other significant parameters can be predicted. The program involves both the development of a heat flow computer model and the experimental measurement of heat flow in a test apparatus especially designed and constructed for this program.

23 (FE—2295-T-1) **Computer-aided industrial process design. Second quarterly progress report, September 1—November 30, 1976.** Evans, L.B.; Seider, W.D. 30 Nov 1976. Contract EX-76-C-01-2295-009. 117p. Dep. NTIS, PC A06/MF A01.

The objective of this project is to develop an advanced computing system for process engineering to be used in the study of fossil energy conversion processes. The system has been tentatively named ASPEN (Advanced System for Process Engineering). Progress was made in the following areas: planning and organization of the project; identification of existing software; development of PLEXSYS; development of physical property subsystem; simulation of coal conversion processes; and work at the University of Pennsylvania.

24 (FE—2336-13) **Modification and operation of the atmospheric ash-agglomerating gasifier on coal. Project 9020 monthly progress report for June 1977.** Sandstrom, W.A. Aug 1977. Contract EX-76-C-01-2336. 31p. Dep. NTIS, PC A03/MF A01.

Task I, Modification and Shakedown of the AAG system, was terminated in May 1977 and a summary report prepared. During June, in Task II, now begun, testing was continued with coke breeze to resolve the L-valve feeding problems and to activate fines recirculation. Fines recirculation and simultaneous ash agglomeration with coke were obtained. The L-valve continued to be a problem though some calibrating data were obtained after scalping off the plus $\frac{1}{2}$-inch from the received coke. Modifications of this device continue and a 3 x 2-inch design will be used in July. Of considerable significance is that we came upon an opportunity to investigate the previously imposed oxygen ratio limitations as applied to the process gas supplied to the grid section of the reactor. It was found that, at least with coke, no such limitation was necessary and further that its removal may improve both agglomerate and product gas quality.

25 (FE—2361-4(Vol.2)) **Development of a fast fluid bed gasifier. Phase 1, Task 1. Interim report, July—October 1976. Volume II. Appendix A: computer results.** Molayem, B. Feb 1977. Contract EX-76-C-01-2361. 121p. Dep. NTIS, PC A06/MF A01.

Results are presented in the form of computer printouts; there is no text.

26 (FE—2433-8) **Environmental assessment of the HYGAS process. Quarterly progress report No. 2, October 1—December 31, 1976.** May 1977. Contract EX-76-C-01-2433. 87p. Dep. NTIS, PC A05/MF A01.

The HYGAS Environmental Assessment program was set up to operate systems for sampling, analysis, and data evaluation to define the fate of potential pollutants generated during operation of the HYGAS Pilot Plant. The objective is to obtain average pollutant concentrations so that the experimental data can be projected to define the environmental effects of a commercial, full-scale HYGAS plant. The initial environmental assessment has been carried out for Rosebud subbituminous coal, which was used for HYGAS Tests 55 to 58. This coal is a nonagglomerating coal that required no pretreatment. The current HYGAS sampling system is directed at plant operation, and proof of the process and additional sampling points have been added to the regular plant samples as part of this environmental program. This report presents a detailed list and flowsheet for all the samples and analyses currently being taken in the HYGAS plant for both the plant operation and the environmental assessment.

27 (FE—2434-15) **Pipeline gas from coal-hydrogenation (IGT hydrogasification process). Project 9000 monthly status report, June 1—June 30, 1977.** Aug 1977. Contract EX-76-C-01-2434. 45p. Dep. NTIS, PC A03/MF A01.

The objective of this project is to continue and advance pilot plant studies (initiated under prior contract) directed at the development of a commercial process for the production of pipeline-quality gas from coal; to demonstrate the feasibility of the HYGAS pilot plant to produce substitute natural gas using lignite, bituminous, and subbituminous coal feedstocks. Tests 62 and 63 were conducted during June. Test 62 lasted 3 days and was terminated because of operational problems in the product-gas quench system. Sixty-eight tons of pretreated coal were fed to the reactor. Test 63 included 7 days of self-sustained operation, and carbon conversions of around 80 percent. This test was terminated when it was impossible to transfer solids from the reactor and from the second-stage gasifier to the steam-oxygen gasifier. Modifications of the liquid-phase methanation unit to eliminate fire hazards were begun and should be completed next month. The quench system is being studied. Also, a cold-flow model is under construction to increase understanding of the initiation of solids flow to the steam-oxygen fluidized bed and the stability of the system to process transients.

28 (FE—2566-05) **Upgrading of coal liquids. Monthly technical progress report, July 1977.** Tan, G.; deRosset, A.J. Aug 1977. Contract EF-77-C-01-2566. 15p. Dep. NTIS, PC A02/MF A01.

First-stage hydrocracking process variable studies on H-Coal gas oil were concluded. At base pressure, data were obtained at one temperature and three space velocities. At 500 psig below base pressure, data were obtained at one temperature and one space velocity. The liquid products from the temperature first-stage H-Coal gas oil hydrocracking run, completed in June, were blended to provide one drum of charge stock for second-stage hydrocracking to gasoline. All required analyses for this stock have been completed. One second-stage hydrocracking run has been completed. A second preparative run has been started to produce feedstock for second-stage hydrocracking to fuel oil. The second shipment of H-Coal atmospheric still bottoms intended for hydrotreating-fluid catalytic cracking is being rerun. Routine inspections of EDS prcess naphtha have been completed.

29 (NP—22167) **Coal process and equipment development facility.** Jan 1977. 18p. Consultants, Inc., Washington, DC.

A concept is presented for a Coal Process and Equipment Development Facility that will both test a variety of coal conversion processes and produce a number of energy products, including critically needed fuels, utilizing currently available technologies. While a number of sites for such a facility with near-by coal deposits exist, West Virginia University and Systems Consultants, Inc. propose a specific site located near Morgantown, West Virginia.

30 (NTIS/PS—77/0477) **Underground coal gasification (citations from the NTIS data base). Report for 1964—May 1977.** Cavagnaro, D.M. Jun 1977. 135p. NTIS PC N01/MF N01.

The bibliography of Federally-sponsored research cites all aspects of in-situ gasification techniques, including rock fracturing, combustion, gas removal, economics, costs, and environmental factors. (This updated bibliography contains 130 abstracts, 47 of which are new entries to the previous edition.)

31 (NTIS/PS—77/0478) **Underground coal gasification (citations from the Engineering Index data base). Report for 1970—May 1977.** Cavagnaro, D.M. Jun 1977. 70p. NTIS PC N01/MF N01.

The bibliography presents world wide research pertaining to underground (in-situ) coal gasification. It includes environmental effects, the different processes and techniques that are used, gas removal, rock fracturing, costs, and economics. (This updated bibliography contains 63 abstracts, 32 of which are new entries to the previous edition.)

32 (PB—266854) **Evaluation of the calcium aluminate bond phase in refractory castables as related to their use in the synthane gasifier. Open file report.** Lankard, D.R.; Peterson, J.H.; Kistler, C.W. Dec 1976. Contracts J0155086;E(49-18)-2219. 72p. NTIS PC A04/MF A01.

This report describes the effects of exposing a dense, high-alumina castable and a low-iron insulating castable to a simulated coal gasification reactor environment for up to 100 hours and at temperatures up to 2,000F. The castables were characterized by chemical analyses, X-ray diffraction, scanning electron microscopy, and strength measurements. Changes in the castables were related to mineralogical and microstructural changes.

33 (TID—27722) **Research in coal-based magnetohydrodynamics. Monthly technical progress report.** Sep 1976. 19p. Dep. NTIS, PC A02/MF A01.

The heavy construction of the 5 MW pressurized-coal gasifier-combustor pilot plant was completed this month. Shakedown tests and debugging of components continue in preparation for start-up. Assembly of combustor internals is in progress. Seven experiments were completed in the atmospheric gasifier-combustor during September using Rosebud seam coal. The results of these tests, as well as data obtained earlier, indicate that coal size consist is the most important factor controlling ash carryover. The percentage of ash carried over in the flue gas can be limited to 10 to 20% if the size consist of the coal is maintained at 80 to 85% greater than 200 mesh. The energy consumed in the MHD seed desulfurization scheme is highly dependent on the type of coal considered. The computer and mathematical support group were engaged in the following activities: (1) debugging and testing of our code for automatic maximization of electrical conductivity using as variables the quantities of oxidizer and seed fed with a fuel of fixed quantity and qualities; (2) recalculation of thermodynamic data for $Al(OH)_2(g)$; (3) continued rewriting of certain time-consuming procedures in our equilibrium code in assembly language; (4) writing the instructions for use of program SCOOP (Stage Combustor Operation Optimizer Program); (5) calculating a voluminous amount of cases in support of inhouse experiments and for design of the 50 MW(t) combustor to be installed at the Component Development and Integration Facility in Montana. Pressure drop and flow visualization experiments were completed during the first two weeks in September.

34 Corrosion aspects in coal gasification plants. Frankel, H.E.; Cox, T.B. (Energy Research and Development Administration, Washington, DC). 26: 200(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

35 Kinetics of gasification in a combustion pot: a comparison of theory and experiment. Eapen, T.; Blackadar, R.; Essenhigh, R.H. (Pennsylvania State Univ., University Park). pp 515-522 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

Reaction of carbon with air in a fixed fuel bed is shown to be controlled by diffusion in the combustion region of the bed, in agreement with all past theories and assumptions, but it is chemically controlled in the gasification region, contrary to most previous assumptions, with a temperature coefficient equivalent to 50 kcal. activation energy. The combustion pot in which the experiments were carried out was refractory lined (with 2.5" walls), of rectangular cross-section (6.5" x 15.5"), and with a bed up to 18" deep resting on a perforated steel plate as a grate. Fuel was mostly coke, in three size grades (approx. 1", 0.625", and 0.375"), with one size grade of coal. Gas compositions of O_2, CO_2, and CO were measured down through the bed. Experiments were carried out at 5 different air rates (5, 10, 15, 20, and 40 scfm): both air and gasification rates overlap with rates found in commercial gasifiers. The results were also compared with Kreisinger's data. The theory used an approximate solution to a prior analysis by Kuwata et al for comparison with the experimental results. Kinetic coefficients were obtained from slopes of log/linear plots of gas compositions with time, notably of (O_2 + CO_2). The velocity constant for the oxygen reaction in particular was found to be proportional to the 0.7 power of the velocity, in agreement with theory. The constant for the CO_2 reaction, however, was found to be highly temperature dependent, with a slope on an Arrhenius plot equivalent to 50 kcal. This generates gasification rates substantially lower than would be possible if the gasification reaction were diffusionally controlled. The results can provide a basis for the mathematical modelling of shaft reactors such as the Morgan or the Wellman-Galusha, with possible extension to the Lurgi which is pressurized and with oxygen and steam in place of air. The results may also be relevant to the problem of underground gasification.

36 Reaction rate analysis of borehole in-situ gasification systems. Stewart, I.M.; Wall, T.F. (Univ. of Newcastle N.S.W., Australia). pp 525-533 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

Performance is reported for quasi-steady state computational models of two zones of borehole type in-situ gasification systems. The plug-flow reduction zone is a close replica of real systems; the well-stirred reactor models some special systems and may be indicative of a wide range of ignition zone conditions. For both models it is postulated that seam moisture evaporation and coal devolatilization occur at some distance (inversely proportional to the advance rate) behind a reacting face of coke and that reaction of these products with coke occurs behind the face. This model produces an apparent reactivity for the system more strongly dependent on seam moisture and volatile content than on the chemical reactivity of the coke. Computations predict that gasification efficiency and combustion stability are sensitive to an optimal combination of seam moisture and of blast moisture. These findings and the predicted gas analyses and efficiencies are generally in line with what published field information is available. The advantageous effect of high moisture content in the gas is to increase reaction rate (by increasing the concentration of a major reactant); this is balanced by the temperature drop due to added heat capacity. The overall effect is so dramatic as to warrant this type of analysis before completing design for field experiments. Laboratory testing on large samples of seam coal is advisable to test the model for detail and obtain better rate coefficients. It is predicted that high ratings and high gasification efficiencies are possible for oxygen-steam gasification either in plug-flow or W.S.R. systems, particularly if preheat can be achieved.

LIQUEFACTION

REFER ALSO TO CITATION(S) 9, 19, 23, 29, 68, 978

37 (CONF-760838—, pp 11p, Paper 5) **Synthoil process.** Akhtar, S. (Pittsburgh Energy Research Center, PA). 1976.

From 3. annual international conference on coal gasification and liquefaction; Pittsburgh, Pennsylvania, United States of America (USA) (3 Aug 1976).

In 3rd international conference on coal gasification and liquefaction.

The goals, schedules, products, flowsheets and economics of the Synthoil coal liquefaction process are given (reproduction of slides with little text). (LTN)

38 (CONF-760838—, pp 14p, Paper 9) **H-coal process.** Kang, C.C.; Kydd, P.H. 1976.

From 3. annual international conference on coal gasification and liquefaction; Pittsburgh, Pennsylvania, United States of America (USA) (3 Aug 1976).

In 3rd international conference on coal gasification and liquefaction.

Three additional H-Coal PDU runs have been completed. PDU Run 2 achieved all planned operating conditions, and demonstrated that very little catalyst breakdown and catalyst loss occurred at commercial gas velocity. PDU Run 3 demonstrated that, under planned Pilot Plant operating conditions for the boiler fuel mode, the fuel oil product would contain 0.5% sulfur from an Illinois No. 6 coal containing 3.5% sulfur. PDU Run 4 demonstrated that design conditions could be achieved in the syncrude mode with recycle of hydroclone overflow containing residual oil and solids to the reactor and result in an increased yield of distillate oil. A precipitation system for solid-liquid separation has been developed which produces a 500°F+ fuel oil product containing 0.065% ash from a fresh hydroclone underflow feed obtained on-line from the PDU. It appears that the major technical hurdles in the H-Coal Process have been cleared, and that the emphasis is shifting to technology verification and product application studies.

39 (CONF-760838—, pp 13p, Paper 11) **Operations at the Wilsonville SRC pilot plant.** Huffman, E.L. (Southern Company Services, Inc., Birmingham, AL). 1976.

From 3. annual international conference on coal gasification and liquefaction; Pittsburgh, Pennsylvania, United States of America (USA) (3 Aug 1976).

In 3rd international conference on coal gasification and liquefaction.

Pulverized coal is mixed with two or three parts of a solvent fraction that is generated internally in the process. This recycled solvent fraction has a boiling range of about 350-800°F. Hydrogen is added to the slurry of coal and solvent and the mixture is preheated and fed into a single-stage reactor or dissolver. The reactor operates at a temperature of 800-875°F, and a total pressure of about 1700 psig. Under these conditions, approximately 93% of the carbonaceous material is dissolved during the residence time of approximately 30 minutes. The hydrogen consumption is about 2-3% of the weight of the coal processed. The effluent from the reactor is passed to a high pressure separator where the liquid and gas phases are separated. The liquid slurry is then subjected to a mineral separation step. Filtration is the method of mineral separation initially used; other techniques such as the use of hydroclones and centrifuges also are being investigated. The filtrate is flashed in a vacuum distillation column. Process solvent is recovered overhead and recycled to slurry the coal feed. Bottoms from the vacuum column form the solvent-refined coal product which solidifies at about 350°F. The gas phase from the high pressure separator is scrubbed with a 20% caustic solution to remove the hydrogen sulfide produced. The solid residue from the filter is discharged to a rotary dryer. The filter residue contains a substantial quantity of wash solvent as an absorbed liquid. The wash solvent is removed as vapors from the rotary dryer, condensed to a liquid, and recycled. In a commercial plant, it is expected that the mineral residue will be fed to a gasifier to produce the hydrogen required in the process.

40 (CONF-760838—, pp 27p, Paper 27) **SRC-II process.** Schmid, B.K.; Jackson, D.M. (Gulf Mineral Resources Co., Denver). 1976.

From 3. annual international conference on coal gasification and liquefaction; Pittsburgh, Pennsylvania, United States of America (USA) (3 Aug 1976).

In 3rd international conference on coal gasification and liquefaction.

Continuing laboratory, pilot plant and engineering work on the Solvent-Refined Coal process, carried out by Gulf Oil Corporation under the sponsorship of the Energy Research and Development Administration, has resulted in the development of an improved version, designated as SRC-II, with a primary product of a low-sulfur distillate fuel oil containing less than 0.4% sulfur, in contrast to the solid fuel produced in the original version of the process. Additional products are pipeline gas, LPG, a light distillate liquid (C_5-400°F.), phenols and ammonia. In the SRC-II process, a portion of the product slurry is recycled as a "solvent" for the coal, rather than using an all-distillate liquid for this purpose. As a result of this slurry recycle and a longer residence time per pass and also partly due to the increased catalytic action of the increased amount

of mineral residue, more of the coal is dissolved and more of the dissolved coal is hydrocracked to lower molecular weight hydrocarbons. As a result of these changes in the product of hydrogenation, the liquid fuel oil (and some gas) can be recovered by vacuum distillation, while the bottoms from the vacuum distillation step are sent to a gasifier for production of hydrogen. The quantity of organic material remaining in the vacuum bottoms is controlled so that it is just sufficient to produce the hydrogen required for the process. In this way, it is possible to avoid complex, unproven process steps such as filtration, mineral residue drying and product solidification, which still require extensive development work.

41 (ERDA—76-95/4) **Coal liquefaction. Quarterly report, October—December 1976.** 1976. 70p. Dep. NTIS, PC A04/MF A01.

In addition to an executive summary and glossary, the following sections are included: Solvent-refined Coal (SRC) Process; Synthoil Process; H-Coal Process; Cresap Test Facility; Clean Coke Process; Liquefaction of Coal by Direct Hydrogenation; Filtration Process and Equipment Studies; Chemicals from Coal; R and D Engineering Services--Hydrocarbonization; R and D Engineering Services--Carbonization of Residue; Zinc Halide Hydrocracking Process; Flash Pyrolysis Coal Liquefaction Process; Operation of Solvent Refined Coal (SRC) Pilot Plant; Donor Solvent Liquefaction Process; Fluid Coking of Coal Liquefaction Residues; Characterization of Coal Liquids; Commercial Scale Ebullated-bed Hydroprocessing of Solvent Refined Coal Extract; Gasification of Residual Coal Liquefaction Products; and Production of Clean Industrial and Transportation Fuels from Coal. (EJH)

42 (FE—1534-44) **Chemicals from coal. Interim report for FMC Corporation COED pyrolysis process, Western Kentucky Syncrude.** Peters, B.C. 15 Apr 1977. Contract EX-76-C-01-1534. 107p. Dep. NTIS, PC A06/MF A01.

This document contains the results of an investigation to determine the suitability of the FMC COED Pyrolysis Process Western Kentucky Syncrude as a petrochemical feedstock. A sample of the whole crude was distilled into four straight run fractions: IBP-350°F naphtha, 350-650°F mid-distillate, 650 to 850°F gas oil, and 850-FBP°F resid. Laboratory studies in metal reactors and computer and mathematical simulations were performed to provide overall material balance data for a conceptual plant. The naphtha was subjected to hydrotreating and reforming studies. The mid-distillate was hydrocracked to produce more naphtha which was further processed by hydrotreating and reforming. The gas oil was hydrocracked to produce more hydrocrackate naphtha which was mathematically hydrotreated and reformed. Steam coil cracking of the various naphtha and mid-distillate fractions was also performed to evaluate their potential as feedstocks for direct olefin production. None of the fractions surveyed was very attractive as an ethylene cracker feed. The reformate from each of the three distillates was then mathematically hydrodealkylated so that each fraction was converted to a product slate consisting of methane, LPG's, benzene, and fuel, along with the total hydrogen consumed. The value of the products obtained per 100 pounds of each distillate was $10.43, $7.29, and $7.12 for the naphtha, mid-distillate, and gas oil, respectively. Based on these values, the gas oil was concluded to be economically unattractive as a petrochemical feedstock. The high aromatic yield obtained from the straight run and hydrocrackate naphthas, however, make these fractions very attractive as petrochemical feedstocks.

43 (FE—2007-34) **Filtration process and equipment studies for coal liquefaction processes. Monthly report, June 1977.** Smith, G.R.S.; Martin, P.C. 14 Jul 1977. Contract EX-76-C-01-2007. 14p. Dep. NTIS, PC A02/MF A01.

Filtration characteristics of Tacoma Filter Feed stock (TFF-216) and Wilsonville Filter Feed stock (SN 25260, Emery Feed Coal) were studied during the course of 24 experimental runs performed on the rotary pressure precoat filter test leaf. Tests at $\frac{1}{2}$ mil/cycle knife blade advance resulted in rates in excess of 325 lb/hr/ft^2 (100 psid, 3- and 4-sec immersions). Tests using CELITE AF13, a coarse grade filter aid, as a non-asbestos filled pre-precoat material indicate essentially no difference in filtration rate or filtrate ash content when compared with previous tests under similar conditions using the asbestos filled FIBRA-FLO 7C as the pre-precoat material. Initial test results on the filtration characteristics of the Wilsonville Filter Feed indicate filtration rates similar to those obtained with Tacoma Filter Feed. Costs based on those developed by Batchelor and Shih have been estimated for an average filtration rate of 500 lb/ft^2/hr. Costs were as low as $0.56/bbl.

44 (FE—2010-09) **Characterization of coal liquids.** deRosset, A.J.; Tan, G.; Gatsis, J.G.; Shoffner, J.P.; Swensen, R.F. Mar 1977. Contract EX-76-C-01-2010. 144p. Dep. NTIS, PC A07/MF A01.

The objective of this investigation is to evaluate the processability of the primary products of coal liquefaction generated by three ERDA sponsored processes: Synthoil, Solvent Refined Coal (SRC), and H-Coal. The study entails actual bench scale processing of coal liquids and an in-depth analytical characterization of charge and product streams. The results are intended to indicate the nature and degree of possible upgrading of primary coal liquids using technology now available in the petroleum refining industry. Six primary coal liquids were filtered and hydrotreated under commercial conditions, using a fixed bed of commercial catalyst. These included Synthoil, H-Coal hydroclone underflow, and four SRC process streams--SRC filter feed, SRC filtrate and solvent refined coal itself, both neat and cutback with process solvent. In all cases catalytic hydrotreating was able to suostantially eliminate sulfur and benzene insoluble matter. A 90% reduction of heptane-insoluble matter and 80% reduction in N content could be achieved with SRC and H-Coal liquids. Catalyst stability was affected by metals and particulates in the feed. None of the products, as received, can be considered an acceptable feedstock to a conventional fixed bed hydrotreating unit. The ash remaining will agglomerate with the solid catalyst pellets and shorten catalyst life. Two of the hydrotreated coal oils, Synthoil and SRC, were further processed under commercial conditions over a fixed bed of commercial hydrocracking catalyst. Catalyst stability was unsatisfactory when the total upgraded products were processed. An asphaltene-free vacuum gas oil derived from hydrotreated Synthoil responded satisfactorily to hydrocracking.

45 (FE—2307-17) **Research and development of rapid hydrogenation for coal conversion to synthetic motor fuels (riser cracking of coal). Annual report, April 1, 1976—March 31, 1977.** Duncan, D.A.; Beeson, J.L.; Oberle, R.D. Jun 1977. Contract EX-76-C-01-2307. 54p. Dep. NTIS, PC A04/MF A01.

The objective of the program is to develop a noncatalytic process for the rapid hydrogenation of lignites and coals in a short residence-time entrained-flow reactor at high temperatures and pressures for the production of feedstock for synthetic motor fuels. Operating temperatures in the range of 900° to 1500°F and operating pressures up to 2000 psig will be used; solids residence time will be varied from 1 to 10 sec. Both a bench-scale unit (5 to 10 lb/hr) and a process development unit (50 to 100 lb/hr) will be used in this program. The development program is based on a commercial concept in which the use of a short residence-time riser reactor, of the type used in contemporary catalytic cracking, is extended to the conversion of coals and lignites to gaseous and liquid products by reaction with gases such as hydrogen, synthesis gas, or mixtures of carbon monoxide and steam. The gases also carry the feed coal through the riser reactor. A maximized production of high-octane gasoline constituents (C_4 to 400°F boiling range including BTX) is an important aspect of this investigation. Light gases (C_1 to C_3) will also be produced and will contain substantial proportions of methane and other light hydrocarbons that could be used either for fuel or for petrochemicals feedstock. Spent char would be used for synthesis gas or hydrogen production for use in the riser reactor. The process is expected to have more favorable economics than other known processes--such as the Bergius or Fischer-Tropsch processes--because of the high space-velocity (volume efficiency) of the reactor and also because less hydrogen would be consumed. The distillate fuel yields are expected to be lower than those of the Bergius process, but gas and gasoline yields are expected to be greater.

46 (FE—2328-12) **Deuterium tracer method for investigating the chemistry of coal liquefaction. Monthly progress report May 1977.** May 1977. Contract EX-76-C-01-2328. 11p. Dep. NTIS, PC A02/MF A01.

The objective of the program is to establish and demonstrate an experimental procedure for a deuterium tracer method for studying the mechanism of coal hydrogenation. Coal hydrogenation and deuteration experiments were performed followed by solvent extraction of the products and mass spectrometric analyses. Experiments were also performed with a hydrogen transfer solvent.

47 (FE—2550-1) **Physical and chemical behavior of liquefied coal in solids separation. Quarterly report, October—December 1976.** Briggs, D.E.; Addington, D.V.; Chou, S.S. Jan 1977. Contract EX-76-S-01-2550. 62p. Dep. NTIS, PC A04/MF A01.

Two model heterocyclic compounds, p,p'-tetramethylenebisphenol and α,α'-hexamethylenebisquinoline were synthesized. The latter compound was found to have an adsorption elution volume seven times larger than 5,6 benzoquinoline, which contains but one basic nitrogen atom. Asphaltenes from an H-c Coal liquefaction of an Illinois No. 6 coal were fractionated in a 10.16-cm ID x 122-cm long preparative scale GPC column for adsorption experiments. Acid-base-neutral separations of the same asphaltenes were effected using the dry HCl technique. The technique was also used to fractionate benzene soluble extract from SYNTHOIL liquefaction of a Pittsburg Seam coal. A filtration study initiated under an NSF grant was completed. specific cake resistances of THF insoluble solids studied range from 0.31 x 10^{12} to 0.7 x 10^{12} m/kg and are inversely proportional to particle size. The filtration of asphaltenes in tetralin at concentrations above 18-20 wt% through the solids increases the cake resistance 100%. At the same concentrations in oils and resins the increase is 40%. In an electrophoresis type cell, the largest deposits were on the positive electrode for asphaltenes

dissolved in pyridine. In tetralin there were small deposits on both electrodes, being somewhat larger on the negative electrode. Eighteen two and three ring aromatic compounds were passed through a fixed bed of 2.5% water deactivated alumina to access the adsorption tendency of various function groups. The acidic and basic fractions were studied.

48 (ORNL—5210) **Evaluation of the SYNTHOIL process. Volume II. Status of development.** Salmon, R.; Edwards, M.S.; Ulrich, W.C. Jun 1977. Contract W-7405-ENG-26. 57p. (ORNL—5209(Vol.2)). Dep. NTIS, PC A04/MF A01.

The Synthoil process for producing heavy desulfurized fuel oil from coal has been under development at Pittsburgh Energy Research Center since 1969. The status of development and technical feasibility of the process are reviewed. This is part of an engineering and economic evaluation based on the conceptual design of a 100,000-bbl/day commercial Synthoil facility. Experimental data are discussed with regard to their adequacy for the formulation of a basis for the process design of such a facility. Potential engineering and equipment problems are analyzed.

49 (ORNL/Sub—4484/1) **Evaluation of a coal liquefaction process using either a nuclear or fossil heat source.** Williams, J.J. Feb 1976. Contract W-7405-ENG-26. 116p. (UEC-UCC—760223). Dep. NTIS, PC A06/MF A01.

This study is the preliminary design of a coal liquefaction plant which uses either a nuclear reactor or fuel gas produced in the plant as the primary heat source for the process. The process is based on a modified H-Coal process. The costs of products produced by these two processes are estimated and compared with each other and with some competing products.

50 **Effect of hydrogen pressure on the hydrogenation reaction of coal.** Maekawa, Y.; Ishii, T.; Takeya, G. (Government Industrial Development Lab., Hokkaido, Japan). **10**: No. 2, 101-103(Apr 1977).

The hydrogenolysis of Sumiyoshi coal was studied at 400°C under the reaction pressure of 110 to 220 atm. The reaction rate constant was calculated from the rate of decrease of unreacted coal. The data obtained were expressed as a first order reaction consisting of two steps. The rate constant in the second step increased linearly with the hydrogen pressure. But the rate constant of the direct production of oil from coal in the first step was almost constant.

51 **Integrated process model of the Fischer—Tropsch process for liquid fuels production from coal.** Hissam, M.A.; Nichols, D.G. (West Virginia Univ., Morgantown). pp 671-675 of In Modeling and simulation. Volume 7, Part 1. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P1.

This paper deals with the development of a computer model of the Fischer-Tropsch process. On the basis of an integrated process flow scheme, the model generates capital and operating-cost information. The model should prove valuable for use in the study of hydrocarbon liquids synthesis to help alleviate our energy shortage.

PYROLYSIS AND CRACKING

REFER ALSO TO CITATION(S) 28, 42, 44

SOLVENT EXTRACTION

REFER ALSO TO CITATION(S) 43, 56

52 (FE—496-137) **Solvent Refined Coal (SRC) Process. Monthly report for the period June 1977.** Aug 1977. Contract EX-76-C-01-0496. 13p. Dep. NTIS, PC A02/MF A01.

The progress of the Solvent Refined Coal (SRC) project by The Pittsburg and Midway Coal Mining Co., at the SRC Pilot Plant at Fort Lewis, Washington, and the P and M Laboratory in Merriam, Kansas for the Energy Research and Development Administration during the month of June 1977 is reported. The Fort Lewis Pilot Plant processed a blend of Kentucky 9 and 14 coal during 25 days of operation in June. Two SRC II material balance runs were completed during this period. Four SRC II runs were completed at the Merriam Laboratory, three exploring the effect of hydrogen circulation rate at lower rates than previously employed in SRC II, and the other an additional attempt to reach a fully lined out slurry-only recycle run with the Loveridge Mine Pittsburgh Seam Coal.

53 (FE—2270-18) **Solvent refined coal (SRC) process operation of solvent refined coal pilot plant at Wilsonville, Alabama. Monthly technical progress report for July 1977.** Lewis, H.E.; Weber, W.H.; Usnick, G.B.; Hollenack, W.R.; Hooks, H.W. Aug 1977. Contract EX-76-C-01-2270. 25p. Dep. NTIS, PC A02/MF A01.

The Wilsonville SRC pilot plant operated 562 hr. or was on-stream 76% of the time during July. the distillation section operated an additional 36 hr. All operational time was used to process Indiana V coal from the old Ben No 1 mine. One material balance was completed and another was in progress at the end of the month. Preliminary analysis of the data indicated that process solvent balance was achieved during both runs. Specification SRC was produced using Fibra-Flo 7-C precoat on the Funda filter. The distillation system has been adjusted and operated to give a consistent boiling range process solvent. This is an improvement over past operating conditions and there should be a resulting consistency in the reaction section of the plant. A short run was made operating both centrifuges for solids separation. The test was terminated before significant data could be collected. Design changes are being made to both systems before additional runs are made. Preliminary results indicate that an improvement has been made in pump life for some pumps handling slurries. the change is due to using a hard-surface coating on the inside of the pump cases.

BY-PRODUCTS

REFER ALSO TO CITATION(S) 1

54 (FE—1724-27) **Utilization of coal conversion process by-products. Quarterly report, December 26, 1976—March 25, 1977.** Solomon, I.J.; Giori, C. May 1977. Contract EX-76-C-01-1724. 32p. (IITRI-C—6322-27). Dep. NTIS, PC A03/MF A01.

A feasibility study has been initiated which is aimed at the manufacture of low cost, thermosetting, cross-linkable polymers by using the carboxylic acid mixture obtained in the oxidation of the coal conversion process chars. The main criteria utilized in the selection of polymerization approaches are: (1) the polymerization process should be commercially feasible; (2) the co-reactant(s) should be low cost, readily available materials; (3) the polymerization should be relatively insensitive to the composition of the char acid mixture, which may vary from batch to batch; and (4) char acids should be an essential constituent of the final product. Several polyester compositions were prepared by condensation of char acid extracts with various glycols and subsequently evaluated as molding materials. Among the various glycols investigated, tetraethylene glycol bottoms, a by-product of the synthesis of ethylene glycol, was found to be a promising co-reactant for polyesterification. Polymerization reactions were conducted under conditions leading to the formation of fusible, partially polymerized resins, which were subsequently cross-linked in a mold with epoxide-functional curing agents in the presence of amine catalysts. Very encouraging results have been obtained up to this point and it appears that commercially valuable polymers can be produced. Larger scale studies, in which physical properties of the polymer can be obtained, are planned.

PROPERTIES

REFER ALSO TO CITATION(S) 44, 46, 47

55 (COO—4227-1) **Coal anion structure and chemistry of coal alkylation. First quarterly progress report, March 1, 1977—May 31, 1977.** Stock, L.M. 1977. Contract EF-77-S-02-4227. 7p. Dep. NTIS, PC A02/MF A01.

Three areas of work are now active. First, work has been undertaken concerning the proton and carbon nuclear magnetic resonance spectra of butylated coal samples obtained from E. Burk of the Atlantic Richfield Oil Corporation Research Laboratory in Harvey, Illinois. Second, work has been undertaken concerning the preparation of perdeuteriotetralin for study of the hydrogen atom transfer reactions. Third, work has been undertaken on the reductive alkylation of Illinois No. 6 coal samples.

56 (EPRI-AF—480) **Nature and origin of asphaltenes in processed coals: the chemistry and mechanisms of coal conversion to clean fuel. Annual report, March 1976—February 1977.** Whitehurst, D.D.; Farcasiu, M.; Mitchell, T.O.; Dickert, J.J. Jr. Jul 1977. 432p. Dep. NTIS, PC A19/MF A01.

Studies have been undertaken to develop a fundamental understanding of the chemistry and structure of coal and coal products and the mechanisms involved in the conversion of coal to soluble products under typical solvent refining conditions. Illinois, Kentucky, and Wyoming coals were investigated. Reactions were conducted in stirred autoclaves at contact times from 0.25 to 420 min. using synthetic recycle solvents. Reaction variables included particle size, coal preparation method, temperature, atmosphere, and solvent composition. Products were characterized in detail utilizing newly developed liquid chromatographic methods. Fractions were further characterized by wet chemical, polarographic, and a variety of spectroscopic techniques, and skeletal structures of SRC's and parent coals were derived. The chemistry of typical recycle solvents was studied. Systematic changes which occur during the transformation

of coal into soluble and upgraded products were studied in detail. Compositional changes monitored included aromatic contents and skeletal structure, and changes in functionality, molecular weight, and elemental composition. Elucidation of the kinetics and mechanisms of functionality changes was aided by an extensive study of the chemistry of isolated SRC fractions and of model compounds under liquefaction conditions.

57 (FE—2035-8) **Enthalpy measurement of coal-derived liquids. Quarterly technical progress report, April—June 1977.** Kidnay, A.J.; Yesavage, V.F. 15 Jul 1977. Contract EX-76-C-01-2035. 38p. Dep. NTIS, PC A03/MF A01.

On June 24, 1975, work was initiated on a 36-month contract for experimental enthalpy measurements on coal-derived liquids. Experimental measurements were attempted for a liquid derived from a Utah coal by the COED process. Operation was not possible because the sample viscosity appeared to increase dramatically with time due to some unusual property of the Utah syncrude. Experimental measurements were completed, however, for two distillates obtained from coal derived liquid samples over the range of 60 to 1500 psia and temperatures from 65 to 750°F. The samples studied were a distillate derived from the Western Kentucky syncrude with an endpoint of 650°F and a distillate derived from the Utah syncrude with an endpoint of 520°F. Methods of prediction of enthalpy developed for petroleum fractions compared well with experimental enthalpies of coal derived liquids at lower temperatures (similarly ordered 300°F) but differed considerably from experimental enthalpies at higher temperatures (similarly ordered 700°F). The methods were completely in error in the two-phase region.

58 **Taking into account a number of design factors having an effect on the construction of return-water, clarification systems.** Samoilik, G.V. No. 9, 63-67(Sep 1976). (In Russian).

Results are presented on the effect of slime content in beneficiated coals and of water consumption on the enrichment. An increase in slime content in beneficiated coals can be expected in the future. The physical and mechanical properties of coals and interfering ores are taken into account in estimating the type of return water clarification systems that will be constructed in the future. A decrease in the use of thickeners is forecast. 7 tables, 1 figure, 6 references. (SJR)

59 **Application of liquid scintillation counting method in irradiation studies of coal.** Patel, K.M.; Kisieleski, W.E. (Argonne National Lab., Ill. (USA)). **28**: No. 4, 425-428(Apr 1977).

Coal was irradiated with ionizing radiation in neutral, basic and acidic solutions of ethanol-1-^{14}C. The reacted coal was then oxidized and the collected $^{14}CO_2$ measured in a liquid scintillation counter. Good reproducibility and efficient and quantitative recovery of $^{14}CO_2$ was observed. The method should find wide application in studies to understand mechanisms of free-radical reactions with coal as well as with organic compounds.

60 **Study of potential determination of ash content in coal layers from gamma logging data in exploration regions of South-Western Donbass.** Zimovets, A.M.; Ruev, E.S. pp 170-173 of In Sbornik trudov Vseoyusnogo zaochnogo politekhnicheskogo institute. Moscow; Vsesoyuznyj Zaochnyj Politekhnicheskij Inst. (1973). (In Russian)

The ash content of coal has been determined from gamma log and from bore core samples for 190 profiles. For two regions of the Donbass the correlation coefficient between the ash content and the measured values of γ-intensity is 0.87 and 0.65. The discrepancies in the ash content determination are analyzed.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 9, 26, 77, 78, 89, 1034

61 (CONF-760838—, pp 30p, Paper 3) **SO_2 control technologies: commercial availabilities and economics.** Ponder, W.H. (Environmental Protection Agency, Research Triangle Park, NC); Stern, R.D.; McGlamery, G.C. 1976.

From 3. annual international conference on coal gasification and liquefaction; Pittsburgh, Pennsylvania, United States of America (USA) (3 Aug 1976).

In 3rd international conference on coal gasification and liquefaction.

While many factors may affect the eventual balance of usage between competing control technologies, commercial availability and economics are often so dominant in evaluating and comparing control technologies that valid conclusions can be drawn. Among these conclusions are: Essentially all coal-fired electric power plants could achieve compliance operation between now and 1985 through the application of currently available continuous SO_2 emission control technologies, singly or in combination. Between now and 1985, the scarcity of low-sulfur coal and its higher cost will restrict use of this fuel to less than half of the total projected power plant coal usage. Between now and 1985, the only significant control alternatives permitting compliance with current SO_2 regulatory requirements are the use of low sulfur coal, coal cleaning, and the application of FGD technology (or FGD in combination with coal cleaning). Capital costs associated with FGD are 3-4 times those associated with low-sulfur coal usage, but the effective total cost of fuel is about 45% greater for low-sulfur coal than for FGD. In comparison to the use of a single approach, FGD/coal cleaning and FGD/low-sulfur coal combinations may be economically and environmentally superior for achieving compliance operation between now and 1985. Coal gasification and liquefaction technologies are expected to be comparatively expensive. Fluidized bed combustion technology is expected to be economically competitive with conventional boilers with FGD; commercial availability is expected about 1985 or later.

62 (CONF-760838—, pp 9p, Paper 12) **Shell flue gas desulfurization process.** Pohlenz, J.B. (UOP Inc., Des Plaines, IL). 1976.

From 3. annual international conference on coal gasification and liquefaction; Pittsburgh, Pennsylvania, United States of America (USA) (3 Aug 1976).

In 3rd international conference on coal gasification and liquefaction.

This is a dry process with two or more reactors in swing operation for acceptance of SO_2 and regeneration of the acceptor. Each reactor, containing a static acceptor bed, is operated throughout the cycle at essentially the same temperature--400°C; heating or cooling of the acceptor is therefore unnecessary. Contact between the flue gas and the acceptor is established in such a way that reactor pressure drop is not affected by fly ash. This is achieved by the application of the parallel-passage design which causes the gas to flow alongside the acceptor mass rather than through it. When the acceptor becomes loaded with SO_2 to such an extent that the limiting removal efficiency is reached, the flue gas flow is switched to a regenerated reactor and the spent acceptor is regenerated with fuel gas. The regeneration off-gas contains sulfur dioxide, water vapor and traces of unreacted fuel gas. Before and after switching from acceptance to regeneration and back to acceptance, the reactor is purged to separate the oxidizing (flue gas) and reducing (regeneration) atmospheres.

63 (CONF-760838—, pp 12p, Paper 13) **Flue gas desulfurization by the Thiosorbic process.** Selmeczi, J.G. (Dravo Lime Co., Pittsburgh). 1976.

From 3. annual international conference on coal gasification and liquefaction; Pittsburgh, Pennsylvania, United States of America (USA) (3 Aug 1976).

In 3rd international conference on coal gasification and liquefaction.

The thiosorbic process is based on the fact that the soluble alkaline species (SO_3^{2-}, HCO_3^-, CO_3^{2-}) form much more soluble salts with magnesium than with calcium. Magnesium salts, therefore, accumulate in the scrubbing liquor according to the supply and blowdown relationship in the system. This allows higher concentrations of sulfite ions, which, according to the solubility product principle, reduces the concentration of calcium ions in the solution. Magnesium becomes by far the most abundant cation. The exhausted scrubbing solution is regenerated in the reaction or mix tank with hydrated lime containing a small amount of magnesium hydroxide. Each mole of SO_2 converts one mole of magnesium sulfite to bisulfite in the scrubber, which is, in turn, regenerated in the mix tank to soluble magnesium sulfite and precipitated calcium sulfite. A continuous blowdown of the scrubbing slurry is clarified in a clarifier thickener. The thickener underflow is taken to sludge disposal and the clear overflow is returned to the process, usually as wash water to the mist eliminators. The Thiosorbic scrubbing liquor is capable of carrying 10-15 times as much dissolved alkalinity--or reacting basic species--in solution than the conventional calcium-based process liquors. This represents several important advantages, which are listed.

64 (CONF-760838—, pp 15p, Paper 17) **Comparison of conventional stack gas scrubbing processes.** Slack, A.V. (SAS Corp., Sheffield, AL). 1976.

From 3. annual international conference on coal gasification and liquefaction; Pittsburgh, Pennsylvania, United States of America (USA) (3 Aug 1976).

In 3rd international conference on coal gasification and liquefaction.

Although a profusion of methods still exists, a conventional technology is clearly emerging. The trend has been in the direction of process simplicity, the use of readily available raw materials, and production of a waste product rather than one for sale. The process that fits in best with these trends is lime-limestone scrubbing. The flowsheet is relatively simple; limestone is a prevalent natural material; and the product, although undesirable in some respects, can be disposed of without the problems involved in creating and maintaining a market. These factors have led most utilities in the U.S. to choose lime-limestone when it becomes necessary to select an FGD

process. This trend has become so pronounced that conventional technology can be said to be made up of only one process, and process differences come about only because process developers follow different routes in trying to solve the several unit problems encountered at various points in the lime-limestone flowsheet. The present paper identifies these problems and evaluates the several approaches used for solving them.

65 (CONF-760838—, pp 17p, Paper 19) **Consol FGD process.** Struck, R.T.; Gorin, E.; Clark, W.E. (Conoco Coal Development Co., Library, PA). 1976.

From 3. annual international conference on coal gasification and liquefaction; Pittsburgh, Pennsylvania, United States of America (USA) (3 Aug 1976).

In 3rd international conference on coal gasification and liquefaction.

A new regenerative process for the removal of 95% or more of sulfur dioxide from power plant stack gases is described. Scrubbing is conducted by circulation of a concentrated aqueous solution of potassium thiosulfate through a pump-around loop containing a packed bed scrubber for SO_2 removal and an external reaction drum. A solution containing a mixture of hydrosulfides, polysulfides, carbonates and bicarbonates is injected into the circulating salt solution just ahead of the reaction drum. The hydrosulfides and polysulfides are quantitatively removed from the circulating salt solution before entering the scrubber by reaction with sulfites formed in the scrubber to produce thiosulfate. The carbonates in the feed solution pass through the reaction drum unconverted, but react in the scrubber with SO_2 to produce the aforementioned sulfites. The net product from the scrubbing process is thus potassium thiosulfate. The scrubber feed solution is produced by noncatalytic reduction of the thiosulfate with a CO-rich gas. H_2S is simultaneously produced which is converted to elemental sulfur in a Claus plant. The scrubbing process was demonstrated on both a 100 ACFM and a 30,000 ACFM pilot plant. Regeneration of the spent reagent was demonstrated in a separate pilot operation. Finally, closed-loop operation was demonstrated with continuous circulation of reagent between the regeneration and the 100 ACFM scrubbing pilot plants. An economic analysis showed the process to be competitive with other regenerable processes.

66 (CONF-760838—, pp 6p, Paper 25) **Flue gas desulfurization process at the D. Bruce Mansfield power plant.** Workman, K.H. 1976.

From 3. annual international conference on coal gasification and liquefaction; Pittsburgh, Pennsylvania, United States of America (USA) (3 Aug 1976).

In 3rd international conference on coal gasification and liquefaction.

With the limited experience acquired to date at the Mansfield Plant, it is impossible to make predictions about the future of this particular desulfurization system. However, major modifications are necessary, the cost of which will be measured in millions of dollars. A wiser course of action would have been to experiment with one scrubber train to develop the process and then install the full-size system.

67 (FE—1782-11) **Evaluation of the particle-precipitating heat transfer surface for high temperature dust control. Final report, July 1975—May 1976.** Lee, M.K.; Honig, E.M. Jr. Jun 1977. Contract EX-76-A-01-1782. 71p. (CERL-TR-E—113). Dep. NTIS, PC A04/MF A01.

Results are presented of an evaluation of the dust-extraction properties of an array of Particle-Precipitating Heat Transfer Surfaces (PPHTS). The PPHTS array consists of a set of combustion system heat-exchanger tubes (rods) with surfaces curved to create aerodynamic forces which remove dust particles from gas streams. The study established the basic operating characteristics of the PPHTS and indicates that PPHTS arrays have potential for collection of submicron particles. Total and fractional particle collection efficiencies determined for three test sections having two different rod cross sections and two different duct cross sections were found to decrease with increasing flow rate. For the conditions tested, rods with deeper, narrower surface cavities had greater collection efficiencies than those with shallower, wider cavities.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 26, 71, 88, 89, 110, 970, 1018, 1407, 1408, 1539

68 (CONF-760838—, pp 77p, Paper 26) **Environmental aspects of coal conversion plant siting and cost of pollution control.** Reddy, G.N. (Argonne National Lab., IL). 1976.

From 3. annual international conference on coal gasification and liquefaction; Pittsburgh, Pennsylvania, United States of America (USA) (3 Aug 1976).

In 3rd international conference on coal gasification and liquefaction.

Environmental analysis of coal conversion facilities have so far only considered individual components, mostly limited to the facility itself. Comprehensive environmental impact statements involving air, land, water and noise pollution, and the entire sequence of activities starting from the mining of coal to the distribution of products have not been developed. However, when one considers the size of these facilities, the overall pollution problem is greatly simplified by having the pollutants generated at a single processing site rather than at multiple points of coal utilization. This does not reduce the complexity of the technical problems associated with the technology involved in controlling emissions from such facilities but it greatly reduces the overall economic impact. The status of coal conversion technology and potential health effects due to exposure to products from coal conversion plants are described briefly. The environmental rules and regulations applicable to coal conversion facilities in 14 states that have potential sites for the location of such facilities and costs of compliance with these regulations are reviewed.

RESERVES AND EXPLORATION

REFER ALSO TO CITATION(S) 1350

69 (NP—22449) **Calvert Bluff (Wilcox Group) sedimentation and the occurrence of lignite at Alcoa and Butler, Texas. Research note 2.** Kaiser, W.R. 1976. 12p. Univ., Bureau of Economic Geology, Austin.

Maps and diagrams are included to describe the stratigraphy; depositional systems; lignite accumulation; and pattern of sedimentation of the subject areas.

70 **Well geophysics in Kuznetsk basin.** Gorodnichev, V.V. pp 85-96 of In Problems of coal basins exploration and sampling techniques. Kemerovo; Kemerovskoe knizhnoe izdatel'stvo (1973). (In Russian)

2 refs.; 5 figs.; 1 table.

Methods are described for lithological analysis of borehole sections in order to determine the thickness and structure of coal layers and the correlations between different sections. The determination of the elements of a deposit by a stratum inclinometer and the determination of the ash content of coal with gammalog are discussed.

MINING

REFER ALSO TO CITATION(S) 108, 109, 378, 977, 1015, 1018

71 (NP—22442) **Observations on current American, British, and West German underground coal-mining practices.** Breslin, J.J.; Anderson, R.J. 15 Apr 1976. 275p. Columbus Labs., OH.

This report is divided into two main sections. The first section deals with the assessment of mine feasibility and is presented in the following parts: Character of the Coal; Marketing and Financing; Physical Conditions; Institutional Constraints; Other Mine Feasibility Considerations; and Analysis of Mine Feasibility Data. The second section deals with mine development and operation and is presented in the following parts: Ground Control; Ventilation; Dust Control; Fires and Explosions; Haulage and Hoisting; Mine Services; Conventional and Continuous Mining Operations; Longwall Mining Operations; Shortwall Mining Operations; Coal Preparation; and Transportation to Market. 219 references.

72 (PB—266728) **Hydraulic stimulation of a surface borehole for gob degasification. Report of investigations.** Maksimovic, S.D.; Elder, C.H.; Kissell, F.N. 1977. 23p. (BM-RI—8228). NTIS PC A02/MF A01.

The hydraulic stimulation of a gob-degasification borehole was evaluated to determine if this procedure would aid in degasifying a longwall panel.

73 (PB—266735) **Shock loss calculations across junctions and splits. Report of investigations.** Edwards, J.C.; Perlee, H.E. 1977. 15p. (BM-RI—8227). NTIS PC A02/MF A01.

One of the major problems associated with underground coal mining operations concerns the design of adequate ventilation systems. Because a coal mine may extend for miles in both directions and may have a high-density of passageway intersections, the pressure head losses (shock loss or minor loss) that occur at these intersections become an important ventilation characteristic. A computer code for laminar, steady state, incompressible, two-dimensional flow was used to calculate shock (minor) loss at the intersections of ventilation ducts. Turbulent flow was simulated using laminar flow equations and an appropriate wall shear stress.

74 (PB—266837) **Geophysical measurement system for delineation of channel sands. Open file report (final).** Cook, J.C. Jul 1976. Contract H0242014. 96p. NTIS PC A05/MF A01.

Channel sand bodies (wants or cutouts) are deposits of barren, hard sediments that interrupt production and pose safety hazards when encountered in underground coal mining. To locate these costly impediments to mining in advance, from the surface of the ground, the seismic reflection method is recommended. High-resolution (high-frequency) techniques for shallow seismic exploration of coal beds have been worked out and are reported, including a field example. Newly developed high-frequency, digital recording equipment was used, together with light-weight shot-drilling equipment and a variety of down-hole seismic impulse sources. Techniques for rapid but complete coverage of a coal prospect area with a crew of two to six men in two or three vehicles are described.

75 **Geomechanical principles of selecting and effecting pillar-free methods of protecting and supporting depleted mine sections.** Ardashev, K.A.; Bazhin, N.P. No. 9, 23-31(Sep 1976). (In Russian).

The economic advantages of not using pillars or blocks of coal as supports are briefly enumerated. Requirements are presented for the selection of blockfree methods in coal mining. A number of methods which do not use columns or blocks are recommended under various conditions of use. The type and parameters of accessory supports are presented and enumerated. (SJR)

76 **Economic efficiency of acquiring pillar-free technology in mines of the production combine Kuzbassugol.** Stankus, V.M.; Sherman, L.M. No. 9, 31-34(Sep 1976). (In Russian).

By introducing the mining of coal without the use of block pillars the production of coal was increased from 29.3 million tons in 1970 to 35.7 million metric tons in 1975 with a total annual savings of 8.8 million rubles. Out of an annual coal production of 166 million metric tons a total of 43.7 million tons (37.5 percent) is dug without the use of block pillars. Further conversion to this technology could lead to savings of 20 million rubles per year. (SJR)

77 **Experience in supporting mine rubble.** Adonkin, A.S. No. 9, 34-38(Sep 1976). (In Russian).

Experience is presented in the maintenance-free support of mine rubble by use of a number of measures which were developed. For example, the length of shaft sinkings per 1000 metric tons of coal was decreased from 9.6 m in 1970 to 8.1 m in 1975, mainly by increasing the length of the longwalls and of the pillars, and also by increasing the reuse of local rubble. Safety measures were improved by strengthening rubble reinforcement. These measures were performed under the management of the production combine "Ukrzapadugol". (SJR)

78 **Storing mine waste in rubble bands with removal of the edge zone of a coal seam.** Litvinskii, G.G.; Babiyuk, G.V.; Zemlyachenko, A.P. No. 9, 39-42(Sep 1976). (In Russian).

A method is presented for storing mine waste in rubble bands with preliminary unloading of stress from the coal stratum by the use of slits of variable rigidity. 1 table, 3 figures, 4 references. (SJR)

79 **Stoppage of the main air circulator in case of an underground fire.** Bolbat, I.E.; Lebedev, V.I. No. 9, 58-60(Sep 1976). (In Russian).

It is shown that the main circulation fan should not be stopped in case of a fire not only in vertical and inclined mines, but also in horizontal mines. In case of a forced outage it is necessary to take special measures which prevent or decrease air recirculation. 4 references. (SJR)

80 **Determining parameters for wetting a roof of broken ore.** Afanas'ev, E.P.; Yastrebov, G.A.; Sergeev, F.N. No. 9, 60-62(Sep 1976). (In Russian).

Deep slanting strata in the Chelyabinskii basin are worked mainly by inclined layers in descending order. The ore is argillaceous, swells readily on wetting, and consolidates well. However it is important that the roof ore be wetted uniformly after coal removal. The main factors having an effect on the distribution of water in the roof ore were found to be the angle of inclination of the stratum, the granulometric composition of the broken ore, the volume of water fed for wetting and the water feed period. The following parameters for feeding a clay pulp are recommended: (1) length of flexible pulp pipe of 7 to 10 m; (2) distance between pulp pipes-25 to 35 m; (3) pressure in the movable pulp pipe -4 to 6 kg/cm^2; (4) pulp feed -7 to 10 cubic meters/hr, and (5) safe, single feed of pulp-15 to 40 cubic meters. By using these recommendations an artificial roof is created for working lower layers of strata at high efficiency. 1 table, 3 figures. (SJR)

81 **New instruments provide rapid detection of toxic gases in underground mines. 81**: No. 7, 145-149(Jul 1976).

82 **Fail-safe assessment of solid-state overcurrent relays using computer simulation technique.** Crawford, W.T.; Ibok, E.U.; Venkata, S.S. (West Virginia Univ., Morgantown). pp 43-46 of In Modeling and simulation. Volume 7, Part 1. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P1.

Solid-state protective devices have been introduced into coal mines recently. In the future, more and more of these devices will find their way into the mines. To keep pace with the newest safety laws to be imposed by Federal Government, these solid-state devices must meet several stringent requirements-the most important being fail-safe performance. This paper is devoted to the fail-safe assessment of the solid-state devices (especially overcurrent relays) using the standard Electronic Circuit Analysis Program (ECAP) software package and comparing the results with suitable laboratory tests. In particular, the paper looks into the problem involved in modeling the electronic components and subsystems of the devices in the ECAP implementation.

83 **Computer simulation and modeling of mine electrical systems.** Morley, L.A.; Trutt, F.C. (Pennsylvania State Univ., University Park). pp 57-62 of In Modeling and simulation. Volume 7, Part 1. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P1.

At first glance, a mine electrical power system appears very similar to any radial distribution for industrial applications. In actuality, it is much different and requires special attention to simulate. Presented is a summary of research work devoted to the modeling of these systems. Included are load flow, faulting, interactive, and mining-machine considerations.

84 **Reliability and sensitivity analyses of undervoltage relays used in coal mine distribution systems.** Ibok, E.U.; Venkata, S.S. (West Virginia Univ., Morgantown, WV). pp 233-237 of In Modeling and simulation. Volume 7, Part 1. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P1.

Electromechanical undervoltage releases found in molded case circuit breakers, perform important functions in the protection schemes of coal mine power systems. Since one of the major aims of the protection scheme is to ensure safety of mine personnel, these devices are required to have a high degree of reliability. At present, mine personnel are thinking of replacing the electromechanical undervoltage releases with the solid-state counterparts which are considered to be more reliable. The theoretical reliability and sensitivity analyses of both types of devices are presented and the results compared. Both analyses are stochastic in nature.

TRANSPORT AND HANDLING

REFER ALSO TO CITATION(S) 4, 19, 58, 61

85 (FE—1792-24) **Coal feeder development program. Quarterly technical progress report, October—December 1976.** 24 Dec 1976. Contract EX-76-C-01-1792. 60p. Dep. NTIS, PC A04/MF A01.

This report covers the work carried out during the fourth quarter of the Phase II effort in the Coal Feeder Development Program. During the reporting period, testing with the Ejector was extended to a 1000-lb/hr system. The mathematical model developed has been verified for gas-driven operation. Preparations are being made to test a steam-driven Ejector. Initial testing with the Kinetic Extruder has indicated shortcomings in the pressure seal design. The test data obtained during limited testing formed the basis for an expanded mathematical model, which was used to design an improved version of the device. This design tool will be verified during tests to be conducted in the first quarter of 1977. New improved pressure seals are being incorporated.

86 (FE—2475-3) **Developing/modifying coal grinding procedures and equipment to produce predictable size distributions during coal preparation. Quarterly progress report, September—December 1976.** Luckie, P.T. 15 Jan 1977. Contract EX-76-C-01-2475. 72p. Dep. NTIS, PC A04/MF A01.

This is the first Quarterly Progress Report for ERDA Contract No. E(49-18)-2475, "Developing/Modifying Coal Grinding Procedures and Equipment to Produce Predictable Size Distributions During Coal Preparation". It covers the period, 20 September to 31 December 1976. The project is broken down into 4 Tasks--

Study Phase, Preparation Phase, Testing Phase, and Reporting Phase. During this research period, work has been conducted mainly on the Study Phase and the Preparation Phase. Work under the Study Phase has been involved with the subtasks--State of the Art Study, Selection of Samples and Laboratory Analysis. The State of the Art Study has emphasized collection of data from manufacturers of coal size-reduction equipment. The Selection of Samples has selected two coal sources out of the three geographically distinct coals. The Laboratory Analysis has centered around the determination of the primary progeny fragment distribution values for various ranks of coal. Work under the Preparation Phase had been solely aimed at preparing the pilot grinding facility. Work during the next quarter will again be under the Study Phase and Preparation Phase.

87 **Improvements in handling water—slime mixtures in coal beneficiation plants.** Borts, M.A. No. 9, 67-72(Sep 1976). (In Russian).

A look is taken at the improvements in treating slime-water mixtures, and at the equipment arrangement. The treatment of flotation wastes is discussed. 3 tables, 4 references. (SJR)

COMBUSTION

REFER ALSO TO CITATION(S) 20, 21, 67, 1035

88 (ANL/CEN/FE—77-1) **Synthetic sorbents for removal of sulfur dioxide in fluidized-bed coal combustors.** Snyder, R.B.; Wilson, W.I.; Johnson, I.; Jonke, A.A. Jun 1977. Contract W-31-109-ENG-38. 42p. Dep. NTIS, PC A03/MF A01.

Synthetic sorbents have been investigated for use in place of limestone for SO_2 emission control in fluidized-bed coal combustors. Sorbents prepared by impregnation of porous alumina with alkali metal or alkaline earth oxides were studied. The most promising sorbent was found to be calcium oxide in alumina. However, the SO_2 reactivity of this synthetic sorbent was less than that for a moderately reactive limestone. Hence, a greater quantity of synthetic sorbent would be needed to meet SO_2 emission standards. The attrition resistance of this synthetic sorbent was found to be greater than that of natural stones; therefore, a larger number of cycles of use would be expected. It is estimated that the use of this synthetic sorbent would reduce the amount of waste sorbent to about one-sixth the amount expected using a moderately reactive once-through limestone. The cost of using this synthetic sorbent is estimated to be about three and a half times the cost expected using once-through limestone. This cost is considered to be too large in view of the expected modest decrease in environmental impact. The synthetic sorbents developed in this study are therefore not considered viable alternatives for limestone in fluidized-bed coal combustors.

89 (ANL/ES-CEN—1019) **Supportive studies in fluidized-bed combustion. Quarterly report, January—March 1977.** Vogel, G.J.; Johnson, I.; Lee, S.H. 1977. Contract W-31-109-ENG-38. 60p. (FE—1780-7). Dep. NTIS, PC A08/MF A01.

These studies support the development studies for atmospheric and pressurized fluidized-bed coal combustion. Laboratory and bench-scale studies aimed at providing needed information on combustion optimization, regeneration process development, solid waste disposal, synthetic SO_2-sorbent studies, emission control, limestones and dolomites from various parts of the country for suitability in fluidized-bed combustors is also included. Reduction in solid waste volumes to reduce the environmental impact of the waste sulfated limestone is one of the major goals of this program. These studies are designed to supply data essential for the application of fluidized-bed combustion units to public utility and industrial systems. This report presents information on: a 10-cycle combustion-regeneration experiment, bench-scale regeneration experiments using Greer limestone, bed defluidization, regeneration kinetics, preparation of synthetic SO_2-sorbents containing metal oxides, limestone characterization, coal combustion reactions, the enhancement of the sulfation rate of limestone by NaCl, evaluation of on-line particle analyzers, and status of flue-gas cleaning studies.

90 (CONF-760838—, pp 5p, Paper 2) **Fluidized coal combustion: what can be done now.** Grant, A.J. (Woodall—Duckham Ltd., Pittsburgh). 1976.

From 3. annual international conference on coal gasification and liquefaction; Pittsburgh, Pennsylvania, United States of America (USA) (3 Aug 1976).

In 3rd international conference on coal gasification and liquefaction.

The principal advantages of lean bed fluidized combustion are discussed. A fluidized combustor will operate on any fuel which has a net calorific value greater than its sensible heat at bed temperature. Provided that fuel feed facilities are available, a fluidized boiler should give design steam output on any solid, liquid or gas fuel. For solid fuels, crushing to achieve the particle size necessary for fluidizing is the only preparation required. Large lumps of coal, wood, etc., can also be fed to a bed of smaller particles. Addition of limestone or dolomite to the bed enables more than 90% of the sulfur from the fuel to be retained in the bed as calcium sulfate. The quantity of oxides of nitrogen, NO/sub x/, released in this process is also lower than that of other combustion systems, mainly due to the relatively low combustion temperatures employed. SO_3 levels are also kept low. An important characteristic of any fluidized bed is the high heat transfer performance that can be obtained with immersed heating surface. By making use of this characteristic or by operating with very high excess air flows, the bed temperature can be controlled within close limits. Normal operation is in the range 1350-1650°F, well below the softening point of the ash. Release of volatile alkali metal salts is also much reduced so that problems usually associated with "difficult" ash fuels may be alleviated.

91 (CONF-760838—, pp 25p, Paper 7) **Fluidized bed combustion.** Keairns, D.L. (Westinghouse Research Labs., Pittsburgh). 1976.

From 3. annual international conference on coal gasification and liquefaction; Pittsburgh, Pennsylvania, United States of America (USA) (3 Aug 1976).

In 3rd international conference on coal gasification and liquefaction.

Compared with competitive systems, fluidized bed combustion processes can utilize a wide range of fossil fuels for electric power generation, steam production or heat utilization to achieve lower costs and to meet environmental requirements. No technical problems have been identified which preclude commercialization. The primary need is for integrated programs to implement the development and commercialize fluidized bed combustion processes.

92 (EPA—600/2-76-212, pp 405-421) **Properties of industrial fuel gases manufactured from coal using commercially proven technology.** Joubert, J.I.; Bienstock, D. (Pittsburgh Energy Research Center). Aug 1976.

From Symposium on environment and energy conservation; Denver, Colorado, USA (3 Nov 1975).

In Symposium on environment and energy conservation.

Gaseous fuels have been manufactured from coal for well over a century. Although coal gasification was once widely employed in the United States, the advent of inexpensive natural gas and petroleum in the 1920s and 1930s virtually eliminated such processes. Industry, which consumes about 45 percent of our natural gas production, is now faced with curtailments in supplies of this fuel. Fuel gases of low (150 Btu/ft^3) and medium (300 Btu/ft^3) heating value could be substituted for natural gas in many industrial applications. Such fuel can be manufactured from coal using existing, well-proven technology. This paper discusses the properties of coal-derived fuel gases relevant to combustion processes. General relations are presented that show that the combustion properties are mainly a function of the fuel gas heating value, and are largely independent of the process and coal used for production of the fuel gas. Various types of commercial coal gasifiers, gas cleanup systems, and gasification costs are discussed briefly. Approaches to utilization of an integrated gasification system, as well as problems to be anticipated in retrofit applications, are also considered.

93 (FE—1511-36) **Pressurised fluidised bed combustion. Quarterly technical progress report, October—December 1976.** Feb 1977. Contract EX-76-C-01-1511. 33p. Dep. NTIS, PC A03/MF A01.

A series of tests are being carried out on the pressurized combustor at Leatherhead, England, to investigate the performance with a deep bed (8 ft) and tube bank. The first part of Test 6 (nominally at 2 1/2 ft/s and 25 percent excess air) has been completed and data on combustion efficiency, heat transfer, heat balances, mass balances, and temperature distributions are reported. Other data are awaiting completion of analyses.

94 (FE—2451-2) **Gas—solids interactions in the distribution zone of a fluidized bed. Phase I. Quarterly report, September 15—December 15, 1976.** Kirwan, D.J.; Vines, S. Jan 1977. Contract EX-76-S-01-2451. 103p. Dep. NTIS, PC A06/MF A01.

The distribution zone of a 60 micron solids fluidized bed was probed with a newly-developed miniature, self-heating thermistor probe to define the gas jet, moving but non-fluidized solids, moving solids, emulsion, and bubble regimes. Data from probings at a gas entry velocity of 100 fps and superficial velocities of 1 and 2 fps and a gas entry velocity of 200 fps and a superficial velocity of 2 fps were used to generate three-dimensional interfaces for the several solids regimes. The effects of entrance velocity, superficial velocity, and type of air entry on location and magnitude of the several regimes are shown.

95 (FE/1536—3) **Corrosion and erosion evaluation of turbine materials in an environment simulating the CPU-400 combustor operating on coal. Final report.** Stevens, W.G.; Stetson, A.R. Apr 1977. Contract EX-76-C-01-1536. 110p. Dep. NTIS, PC A06/MF A01.

This program was performed to assist in analysis of the gaseous, vapor phase, and particulate environment from a limestone fluidized bed combustor operating on Illinois No. 6 coal and to predict the effect of the environment on a power extraction gas turbine. The particulate material is primarily anhydrite ($CaSO_4$) with hematite (Fe_2P_3), and quartz (SiO_2). The particle size out of the dual stage multicone filters is primarily less than 3μm. Alkali salt content was low. An ash containing 80 ppM of alkali chloride was only mildly corrosive at a typical turbine operating condition, 816°C (penetration was only 77μm [0.003 inch]/10,000 hr). With this low corrosion rate, coatings are probably not needed for the environment but chromized and ceramic coated alloys are superior to aluminized alloy in the chloride containing environment. Erosion/fouling thresholds were determined for the two system ashes and a synthetic ash (contained major constituents in the ash only and was low in alkali). Fouling can be expected from the fly ash above about 470°C and can begin as low as 400°C. Fouling appears to be the principal deterrent to the use of coal-fired gas turbines based on this investigation although erosion may become significant in lower temperature turbine stages and during spall of deposited ash. At the lowest particle concentration objective set to date for dust separation systems (70 mg/m³), a buildup of a deposit 2500μm will occur in 200 hr. Considering the difference in mass flow between the rig and a low compression ratio gas turbine (6:1), the noted buildup could occur in 1/6th the time.

96 (LBL—6339) **Combustion of coal in an opposed flow diffusion burner.** Chin, W.K.; Sawyer, R.F. 1977. Contract W-7405-ENG-48. 21p. (CONF-770561—2). Dep. NTIS, PC A02/MF A01.

From Technical meeting of the Canadian Section of the Combustion Institute; Banff, Canada (26 May 1977).

The utility of the opposed flow diffusion flame (OFDF) apparatus for the study of the steady state combustion of gaseous, liquid, and polymer fuels has been recognized and utilized by a number of researchers. We have employed this configuration to observe the steady state diffusion flame combustion of pressed pulverized coal and graphite in an opposed flow of an oxygen/nitrogen mixture. Initial efforts have focused upon the pressing of pulverized coal into cylindrical rods of homogeneous properties, including the effect of binders and water content, the demonstration of the possibility of steady state burning of a fuel with a significant ash production, the determination of sample porosity, the measurement of burning (linear regression) rates, and the investigation of the primary experimental parameters, oxidizer flow velocity and oxygen fraction. Burning rates were observed to increase with oxidizer velocity and oxygen mole fraction. Because of the well controlled combustion environment and steady state burning which are characteristics of this experimental technique, additional measurements are suggested and are being pursued. These include the determination of the solid and gas phase temperature profiles, extraction of thermal diffusivity data under burning conditions, measurement of gas phase composition profiles, investigation of the relative importance of surface oxidation by oxygen and by carbon dioxide, and the determination of the fate of nitrogen contained in the fuel.

97 **Combustion and flame propagation in coal systems: a review.** Essenhigh, R.H. (Pennsylvania State Univ., University Park). pp 353-374 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

Coal particles in combustion can pyrolyse, swell, graphitise, and react internally or externally or both. Mechanisms determining or controlling the reaction rate can include: boundary layer diffusion (generally controlling for particles greater than 100 microns), pore diffusion, or surface reaction with alternatives of adsorption control or desorption control, or some intermediate. Present evidence on particles in flames is that swelling in oxidizing conditions is likely to be relatively mild, about 10% in diameter. Reaction orders, which provide information on the relative dominance of the adsorption and desorption processes, are uncertain. Numerical values favor $^1/_2$ to unity; very low temperature chemisorption of oxygen on carbon, however, (at -70°C) implying a very low adsorption activation energy, indicates otherwise. There is limited evidence that the reaction order is zero to $^1/_2$, with activation energies of 20 to 40 kcal identified with desorption. Coal flames propagate by several mechanisms. Rates of heating in all cases (including the fixed bed) are in the range 10 to 10^6 or 10^7 deg C/sec. In explosion flames, propagation is by turbulent exchange, probably with heterogeneous ignition; in full flame furnaces, propagation is by radiation if there is no backmix flow, with either heterogeneous ignition or prior pyrolysis; in small flame systems, propagation is by downstream pyrolysis and upstream diffusion. Qualitative mechanisms are being elucidated by quantitative investigations. Accurate predictive quantitative theories, however, do not yet exist; neither is it yet possible to predict with any confidence the combustion behavior of one coal from another. Work is moving steadily in that direction, however.

98 **Propagation of laminar pulverized coal—air flames.** Smoot, L.D.; Horton, M.D.; Williams, G.A. (Brigham Young Univ., Provo, UT). pp 375-387 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

The propagation of laminar, coal-air flames has been studied experimentally and theoretically. Measurements of flame velocity have been made for coal-air mixtures in a downward flowing, 4 in. diameter, flatflame burner at atmospheric pressure. Flame velocities of 14 to 22 cm/sec and 16 to 33 cm/sec were obtained with 33 micron and 10 micron Pittsburgh coal respectively, depending upon coal concentration. Probe temperature profiles and concentration samples on each side of the flame about 1 cm thick suggest a rapid devolatilization process, while photomicrographs show softening, slight swelling and increased porosity of the coal during reaction. A generalized model for a flame propagating in laminar, premixed particle-gas mixtures was formulated, assuming particle-gas dynamic equilibrium and uniform pressure. Effects of gaseous diffusion, coal pyrolysis, char oxidation, and gaseous reaction were considered. The unsteady state equations were solved numerically using finite-difference techniques. Flame velocity predictions, neglecting radiation, were generally within 25% of measured coal values. The theory suggests that in a laminar coal-dust flame, gas phase diffusion and conduction, gas-particle conduction, and coal pyrolysis are important rate-determining steps, while hydrocarbon oxidation and char oxidation may not be rate-limiting. The importance of gas-phase diffusional processes in such flames is suggested.

99 **Pulverized coal combustion: the influence of flame temperature and coal composition on thermal and fuel NO/sub x/.** Pershing, D.W.; Wendt, J.O.L. (Univ. of Arizona, Tucson). pp 389-399 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

A laboratory combustor was used to investigate the factors that influence the conversion of fuel nitrogen in coal during coal combustion. Fuel NO was isolated by experimentation utilizing Argon/Oxygen/Carbon Dioxide mixtures as the oxidant, and care was taken to compare cases with air at matched conditions. For both well mixed and slowly mixed flame types, fuel NO contributed over 75% of the total NO emissions for all conditions examined. Fuel NO was insensitive to temperature changes except when the adiabatic flame temperatures were above 2480°K (4000°F). At the highest adiabatic flame temperature, 2580°K (4200°F), a 10% increase in fuel NO was observed. Four different coals and one coal char were investigated. Fuel NO could not be correlated with fuel nitrogen content alone, even though aerodynamic conditions were kept constant. Fuel nitrogen conversion to NO during pulverized char combustion was 12 to 16% at a stoichiometric ratio of 1.15 compared to 28% for a pulverized coal of the same nitrogen content. Furthermore, in contrast to the coal results, NO emissions from char combustion were not greatly influenced by changes in injector design. The implication is that although conversion of fuel nitrogen to NO may be relatively low during the char burnout regime of coal combustion, the residual "char NO" may be especially resistant to abatement by modifications of the burner aerodynamics.

100 **Optimum conditions for the combustion of low-calorific coal dust in swirl burners.** Wroblewska, V. (Inst. of Power Engineering, Warsaw); Zelkowski, J.; Wojcicki, S. pp 401-410 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

The present situation of the world fuel market makes it necessary to use low-calorific coal for the production of power. Numerical analysis of the combustion process shows the existence of a relation between the properties of coal and the mixing processes in the stream issuing from the burner. Model tests and full-scale tests of a swirl burner reported here confirmed the results of the analysis. It has been found that for each grade of coal, there is an optimum mass exchange in the jet issuing from the burner, which can be controlled by the swirl number and the geometry of the burner. As compared to the corresponding region for high-calorific coal, the range of stable operation of burners for low-calorific coal is shifted toward considerably lower mixing parameters.

101 **Coal devolatilization at high temperatures.** Kobayashi, H.; Howard, J.B.; Sarofim, A.F. (Massachusetts Inst. of Tech., Cambridge). pp 411-425 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

Devolatilization of a lignite and a bituminous coal was studied at high temperatures under rapid heating conditions. Devolatilization rates were measured in a flow furnace designed to yield heating rates of 10^4 - 2 x 10^5 K/s, temperatures of 1000 to 2100°K, time resolution down to a few milliseconds, product quenching rates of 10^6K/s and good particle collection efficiencies. The volatile yields in this study were determined both by difference in the weights of coal fed and char collected and by use of ash as a tracer. Volatile yields of both coals increase significantly with temperature, from about 30% (d.a.f.) at 1260°K and 20ms to about 63% at 2100°K and 25ms. The maximum volatile yields were significantly in excess of the 46% value given by the ASTM proximate volatile test. The yields are even higher when an estimated correction is introduced for condensed material produced during devolatilization that is collected with the char residue. Correlation of the pyrolysis kinetics with a single Arrhenius type rate expression, assuming first order behavior with respect to volatile matter remaining in the char, yielded an apparent frequency factor of about 6.6 x 10^4 s^{-1} and an apparent activation energy of about 25 kcal/mole. These results are consistent with an extrapolation to higher temperatures of data previously reported in the literature for similar coals. An empirical model based on two competing overall reactions gave a better fit of the data over all of the conditions of the present study than was obtained using the single-reaction model.

102 Rapid devolatization of pulverized coal in hot combustion gases. Ubhayakar, S.K.; Stickler, D.B.; von Rosenberg, C.W. Jr.; Gannon, R.E. (AVCO Everett Research Labs., MA). pp 427-436 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

An experimental and analytical study on the rapid devolatilization of pulverized bituminous coal injected and entrained in hot combustion gases flowing in a constant cross-section gasifier is presented. Data on the weight loss through rapid pyrolysis, on the temperature of the heterogeneous medium, and on the composition of the overall products are correlated with an analytical model incorporating two volatile-producing competitive first-order Arrhenius reactions followed by cracking of the volatiles. The experimental parameters are the mass fraction of coal fed into the combustion gases (0 to 0.12), the input gas temperature (1800°K to 2250°K), three particle size distributions for the same type of coal, and the residence time in the gasifier (7 to 70 ms). All data pertain to tests conducted at a pressure of one atm. Heating rates up to 10^5 °K/s and volatile product yields up to 68% of the original dry, ash-free coal are observed. Analysis of the data suggests that a significant fraction of these volatiles crack to soot and hydrogen, and that the cracking fraction increases with the coal fraction in the input gases. The fraction of the volatiles which crack in the gas phase vs. those which crack within the particles is deduced from the data.

103 Fluidized combustion of coal. Beer, J.M. (Massachusetts Inst. of Tech., Cambridge). pp 439-460 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

Fundamental and engineering aspects of fluidized combustion are reviewed. The main areas discussed include: the application of the two phase theory of fluidization to the combustion of coal, the relevance of available information on the kinetics of volatile evolution, volatile combustion and of the carbon-oxygen and carbon-carbon dioxide reactions to the combustion of coal in the fluidized bed, the retention of sulfur by the addition of sorbents to the bed solids and the conversion of fuel nitrogen to NO followed by its partial reduction by char to N_2, the rates of heat transfer to tubes immersed in the bed, and the effects of operation at elevated pressures. Finally research needs arising from the practical application of fluidized combustion are discussed.

104 Influence of air staging on the NO emission from a fluidized bed coal combustor. Gibbs, B.M.; Pereira, F.J.; Beer, J.M. (Univ. of Sheffield, Eng.). pp 461-474 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

Experiments have been carried out on a 30 cm x 30 cm square sectioned fluidized coal combustor to investigate the influence of air staging on the NO emission. In this operational mode the bed, primary stage, is maintained at sub-stoichiometric conditions whilst the balance of the combustion air (secondary air) is injected into the freeboard. The experimental results showed that the NO emission is substantially reduced for staged operation when compared to conventional operation. The extent of NO reduction for staged operation increased with the proportion of secondary air injected, and with bed temperature. At 800°C bed temperature, a reduction of 33% in the NO emission was achieved if 25% of the combustion air was injected into the freeboard. The elutriation loss from the combustor for staged operation was greater than that observed for conventional operation, and increased with the fraction of secondary air injected; the CO emission for staged operation was lower than that in conventional operation. Measurement of the axial NO concentration profile in the bed and freeboard showed that the NO emission in the vicinity of the coal feed is comparable for staged operation to that in conventional operation, but is reduced below that of conventional operation by chemical destruction higher in the bed and freeboard. NO reduction experiments were carried out in a 7.5 cm diameter batch combustor to investigate the nature of the chemical destruction of NO in staged operation. Results of these experiments showed that coal, coal volatiles and char will reduce NO emissions; in particular char in the absence of oxygen was found to be very effective in reducing NO emissions especially at bed temperatures of 800°C or higher and with char sized 500 μm or less.

105 Evolution of nitrogen and other species during controlled pyrolysis of coal. Blair, D.W.; Wendt, J.O.L.; Bartok, W. (Exxon Research and Engineering Co., Linden, NJ). pp 475-489 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

An experimental and theoretical investigation of coal pyrolysis focused on determination of species evolved from single coal particles and on the rates of mass evolution as functions of temperature, heating rate and coal composition. Species measured were CH_4, CO, CO_2, C_2H_2, C_2H_4, C_2H_6, HCN and NH_3. Total mass evolved was compared to total nitrogen evolved for various pyrolysis temperatures. The former was strongly coal composition dependent, while the latter was not. About half of the total volatiles and 85% of the nitrogeneous species do not evolve as the light gases listed above. A new non-gravimetric method for determination of time resolved volatilization rates produced data that compared well to a mechanistic volatilization model in which physical processes inside the particle were described. Fluid flow within a coal particle was found to be important in determining overall gas evolution rates. The results support the hypothesis that, during combustion, nitrogeneous species are evolved late in the volatilization sequence, with a low escape velocity at the particle surface.

106 Devolatilization and oxidation of coal nitrogen. Pohl, J.H.; Sarofim, A.F. (Massachusetts Inst. of Tech., Cambridge). pp 491-501 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

The pyrolysis of the nitrogen content of coal was studied by rapidly heating dispersed pulverized particles of a lignite and a bituminous coal to temperatures of 1000 and 2100 K. Nitrogen evolution paralleled that of the total volatiles with the notable exception that little nitrogen was released until 10 to 15% of the coal had been devolatilized. A pseudo-first order rough fit of the nitrogen pyrolysis data yielded a rate constant of 9.3 x 10^3 exp (-22,700/RT) sec^{-1}. Oxidation of the coal was studied in a laminar diffusion flame produced by injecting the coal particles into a flowing helium/oxygen mixture. At a furnace temperature of 1500 K, the conversion of the nitrogen in the coal to nitric oxide was found to decrease from about 60% at a fuel equivalence ratio of 0.2 to 10% at equivalence ratios above 1.5. At the higher equivalence ratios, however, 30% of the char remained unreacted and 45% of the original coal nitrogen was retained in the char. Similar oxidation experiments were conducted with char produced by devolatilizing coal at 1500°K under conditions at which the char retained about two-thirds of the original coal nitrogen. Conversion to nitric oxide of the nitrogen retained in the char was significantly lower, by factors of two to three, than conversion for coal nitrogen but showed a similar trend with fuel equivalence ratio. From the difference of the coal and char oxidation results it was inferred that, at a furnace temperature of 1500°K, sixty to eighty percent of the NO/sub x/ was contributed by the oxidation of nitrogen released with the volatiles and that the conversion efficiency of volatiles to NO/sub x/ and its dependence on fuel

equivalence ratio were similar to data previously reported in the literature for the oxidation of model fuel nitrogen compounds burned in laboratory premixed and diffusion flames.

107 Environmental aspects of low Btu gas combustion. Heap, M.P. (Ultrasystems, Inc., Irvine, CA); Tyson, T.J.; Cichanowicz, J.E.; Gershman, R.; Kau, C.J.; Martin, G.B.; Lanier, W.S. pp 535-545 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

Nitrogen oxide emissions from power plants burning low Btu gas derived from coal were investigated using a kinetic model which included over 100 reactions. The model was validated by comparison with the best available experimental data and then applied to idealized combustor configurations for two representative combined cycle systems: (1) an advanced-technology high-temperature gas turbine with a waste heat boiler, and (2) a supercharged boiler with a current-technology gas turbine. In both cases staged combustion schemes involving rich primary zones and controlled mixing secondary zones were found to provide for minimum NO/sub x/ emissions. The calculated minimum NO/sub x/ levels (corrected to three percent O_2, dry) were 105 ppM for the high-temperature turbine case and 100 ppM for the supercharged boiler case. These results indicate that combustor design has a strong potential for controlling NO/sub x/ from advanced systems fired with ammonia-containing low Btu gas.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 1006, 1019

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 71, 77, 79, 82, 84, 378

108 Determination of combustible volatile matter in coal mine roadway dusts by backscatter of x-rays from a radioisotope source. Ailwood, C.R.; Bunch, K. (New South Wales Dept. of Mines, Sydney (Australia)); Fookes, R.A.; Gravitis, V.L.; Watt, J.S. (Australian Atomic Energy Commission Research Establishment, Lucas Heights. Isotope Div.). No. 261, 47-51(Mar 1977).

The combustible volatile matter in coal mine roadway dusts (CVM) has been determined using x-ray backscatter techniques. The correlation between x-ray and chemical techniques is reasonably good for the 92 samples from collieries on the Bulli seam, and the maximum error expected at the maximum level of 11.5 weight per cent CVM permitted in the N.S.W. Coal Mines Regulation Act, 1912, as amended, is about +- 2.5 weight per cent. This x-ray technique can be used only when the combustible volatile content of the coal matter (CVM) varies within a limited range, and a separate calibration is required for each coal seam. Portable equipment based on a radioisotope x-ray source and digital ratemeter makes possible simple and rapid analysis, and with adaptation to use in coal mines should lead to much more comprehensive testing of roadways and hence improved overall prevention of coal dust explosions.

109 Interactive program for checking coordination of protective devices. Miller, J.H. (Consolidation Coal Co., Wana, WV); Stanek, E.K. pp 51-56 of In Modeling and simulation. Volume 7, Part 1. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P1.

A presentation is made on how a low-voltage electrical system can be described, along with pertinent protective device information by responding to queries from an interactive computer program using a remote terminal. The program takes the data and checks to see if the protective system clears faults at each bus of the system. The purpose of the program is to aid Mining Enforcement and Safety Administration (MESA) inspectors in the detection of hazardous power systems in coal mines.

REGULATIONS

REFER ALSO TO CITATION(S) 1009, 1018

110 (NP—22137) Summary of surface mining reclamation laws in the Mountain—Plains states. Oct 1976. 60p. of Rocky Mountain States, Inc., Denver, CO.

This is a Regional Background Paper from the Federation of Rocky Mountain States, directed by the governors of Colorado, Montana, New Mexico, Utah, and Wyoming. It contains summaries of surface mining reclamation laws of eight states in the Mountain-Plains region of the United States. A table comparing some attributes of the laws and an overview of recent federal actions concerning reclamation guidelines are also provided. This paper was prepared under a directive of the Environmental Committee of the Federation's Natural Resources Council.

PETROLEUM

REFER ALSO TO CITATION(S) 953

RESERVES

REFER ALSO TO CITATION(S) 111

GEOLOGY AND EXPLORATION

REFER ALSO TO CITATION(S) 173, 1350

111 (CONF-770836—P1, pp D.9.1-D.9.7) Heavy oil resources of Kansas—Missouri—Oklahoma. Wells, J.S. (Missouri Dept. of Natural Resources, Rolla); Ebanks, W.J. Jr.; Roberts, J.F. 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

An ERDA-funded program to inventory heavy oil deposits occurring within Pennsylvanian sandstones in northeastern Oklahoma, southeastern Kansas and western Missouri was started in June of 1976. Specific information about the thickness and areal extent of the several sandstone bodies that contain oil and the distribution of oil within them is being compiled and evaluated for resource base figures for each of the three states. Core drilling to complement existing data is being carried out within the three states. Thirty-three test holes have been drilled and logged in Kansas. By the end of August 1977, an estimated 16 test holes are projected for completion in Oklahoma and an estimated 50 test holes are projected in Missouri. Preliminary maps indicate that the areal extent of oil-saturated sandstone within the tri-state area is somewhat less than had previously been calculated. Occurrences are discontinuous and appear as relatively small pods in areas where gross sand thickness seems to be the greatest.

112 Carbon and nitrogen isotopes in hydrocarbon research and exploration. Stahl, W.J. (Bundesanstalt fuer Geowissenschaften und Rohstoffe, Hannover (Germany, F.R.)). **0**: No. 2, 121-149(Aug 1977).

32 refs., 28 figs., tables.

The present knowledge of C- and N-isotope variations in hydrocarbons is reviewed including some very recent and up to now unpublished results. Stable-isotope techniques are shown to be useful for: (a) Environmental identification of organic source materials. (b) Evaluation of the influence of migration. (c) Recognition of bacterial degradation. (d) Quantitative determination of the maturity of CH_4-producing organic source materials. (e) Characterization of and differentiation between various crude oil accumulations. (f) Correlation of crude oils with source rocks. Especially, the maturity of CH_4 as determined by isotope techniques is of considerable importance in hydrocarbon exploration.

113 Kerogen studies and geological interpretations. Dow, W.G. (Getty Oil Co., Houston, TX). **7**: No. 2, 79-99(Apr 1977).

Kerogen is defined as the portion of organic matter in sedimentary rocks that is insoluble in organic solvents. It is formed from formerly living organic materials by diagenetic processes in the first few hundred meters of burial and is partially converted, under the influence of temperature and time, into petroleum by a series of complex, first-order reactions, termed catagenesis. The quantity and quality of petroleum formed is controlled by the concentration, type, and thermal maturity of the kerogen present in source beds and these parameters comprise the basis of all source bed studies. Catagenesis of hydrogen-rich algal and liptinitic kerogen accounts for most of the oil and gas generated in sedimentary rocks. Hydrogen-deficient, humic kerogen can yield only limited quantities of dry gas and some components of kerogen have little or no capacity to generate petroleum. The convertibility of any specific kerogen to petroleum can be

estimated from its elemental composition and thermal maturity as defined by the reflectance of vitrinite. Kerogen studies play an important role in identifying effective source beds in order to predict the amount, type, and distribution of petroleum that can be expected in a basin. Maturity data is also useful in identifying certain geological features in wells, defining the provenance of sediments, unravelling the sedimentary and tectonic history of basins, and determining the boundaries between diagenesis, catagenesis, and metamorphism. Incorporation of kerogen studies and other geochemical data into conventional exploration programs will become essential as the search for petroleum becomes more difficult and expensive.

114 Petroleum transformations in reservoirs. Milner, C.W.D. (Imperial Oil Ltd., Calgary, Alta.); Rogers, M.A.; Evans, C.R. 7: No. 2, 101-153(Apr 1977).

The influence of post-pooling transformation processes on the composition of crude oil is often more important than that of source facies and transformations resulting from migration. The principal processes that alter hydrocarbons in the reservoir are maturation (thermal-time alteration), gas deasphalting, biodegradation and water-washing. The exploration geochemist should be able to interpret correctly the nature of crude oil and natural gas composition in accordance with all these geochemical controls. The most important is thermal alteration. Still the most difficult geochemical subject to rationalize with respect to the nature of petroleum is the method and staging of migration, but uncertainties can be avoided to some extent by going back to the source rocks themselves and using the composition of the organic matter that may be extracted from them to make predictions about hydrocarbons in the reservoir. As more examples of compositional changes in petroleum are documented, it becomes increasingly easy to define reliable parameters that describe the petroleum evolutionary process. The most rarely seen and least understood composition with this process is that for pooled oils that remain relatively unaltered; in other words, that have retained most of their "original" or "immature" characteristics. Several examples are described that may improve our understanding of such oils, especially where the problem is one of distinguishing between "immaturity" and degradation.Natural gases behave differently from oils because they are far more mobile in the subsurface, and may be generated from a wider range of sources over a wide range of thermal conditions. Natural gases may form independently of oils, are among the end products of the alteration of oils, and can themselves be alteration agents. The "wetness" of hydrocarbon gases can be used as a maturation index.

115 Use of stable carbon isotopes in hydrocarbon exploration. Fuex, A.N. (Shell Development Co., Houston, TX). 7: No. 2, 155-188(Apr 1977).

The use of ^{13}C as a natural tracer in hydrocarbon exploration is discussed in theory and through examples. In general the carbon isotopic composition (expressed as delta ^{13}C values) of a hydrocarbon depends upon (1) the ^{13}C content of the source material, (2) any fractionation attendant on its formation, and (3) any fractionation subsequent to its formation. Thus, delta ^{13}C data can potentially provide information on the source, generation, migration, and alteration of hydrocarbons. Delta ^{13}C values of high-molecular-weight hydrocarbon components of oil and rock samples are relatively free of both primary and secondary fractionations. Thus with oils and rocks, delta ^{13}C data have correlation as their primary use, both oil-to-oil and oil-to-rock. Delta ^{13}C values of natural gas components, in contrast to oils, are greatly affected by primary fractionations and, in some cases, secondary fractionations. Thus delta ^{13}C data primarily provide information on gas type (i.e., bacterial versus thermal origin), maturity and nature of the parent organic material. Because of this, the isotopic composition of gas components provides information regarding association or non-association with oil generation. And thus, it is useful in both oil and gas exploration. Stable carbon isotope analysis is probably as useful in hydrocarbon exploration as any other single analytical technique of organic geochemistry. However, as with any other technique, it should not be used alone, but always in conjunction with geological data and at least some additional geochemical data.

116 Sulfur isotope studies and their role in petroleum exploration. Krouse, H.R. (Univ. of Calgary, Alberta). 7: No. 2, 189-211(Apr 1977).

Since sulfur has tended to be considered as almost a contaminant rather than an integral component of petroleum, sulfur isotope studies have not received as much attention as that accorded other exploration methods. However, their capability in elucidating many problems in evolution, migration, and alteration of petroleum, has been demonstrated. Since oil exploration tends to be deep, recovered cores and fluids play major roles. Sulfur isotope measurements on these materials, in conjection with other data, can more fully characterize basins and direct recovery towards more desirable crudes.

117 Formation waters and hydrodynamics. Coustau, H. (Societe Nationale des Petroles d'Aquitaine, Pau, France). 7: No. 2, 213-241(Apr 1977).

Formation water geochemistry and hydrodynamics, referred to in this article as "fluid geology", have been used, for a long time, as an efficient exploration tool. In the first part of this paper, a review is made of the three domains in which this tool can be used: evaluation of fields and pools (hydrocarbon distribution, tilt phenomena, production and salinity anomalies, genesis), evaluation of their prospects (hydrodynamic gradients, petroleum indicators) and basin evaluation (hydrodynamic pattern, invasion by meteoric waters, type of reservoir cementation). The second part explains the role played by fluid geology in the discovery of the Meillon-St. Faust field and in the exploration of the Lacq Meillon Basin (Aquitaine, southwestern France).

118 Use of hydrocarbon sniffing in offshore exploration. Sackett, W.M. (Texas A and M Univ., College Station). 7: No. 2, 243-254(Apr 1977).

The solution of natural hydrocarbon gases from offshore bottom seepage into the overlying water column makes possible the use of hydrocarbon sniffing as an exploration tool. Modern sniffers usually consist of a gas breakout system, sorbents to concentrate the hydrocarbons and a gas chromatograph equipped with a flame ionization detector to separate and measure individual hydrocarbons. Recent studies on the hydrocarbon composition of fourteen seep gases, indicating that thirteen are pure methane (>99.8%) of biological origin, downgrade the probability that a given bubbling seep is indicative of an underlying liquid petroleum deposit. Sniffing for C_3—C_6 hydrocarbons in near-bottom waters maximizes chances for success in offshore liquid petroleum exploration.

119 Chemistry of marine petroleum seeps. Reed, W.E.; Kaplan, I.R. (Univ. of California, Los Angeles). 7: No. 2, 255-293(Apr 1977).

Natural oil seepage contributes approximately 10% (0.6×10^6 metric tons per year) of the annual input of petroleum hydrocarbons to the marine environment and half of that arises from the continental shelves of the circum-Pacific. Chemical properties of submarine petroleum seeps are reviewed, focusing on those of the Southern California Borderland, in relation to crude oil produced in the same geographic area, the compositional changes due to weathering in the marine environment, and the hydrocarbon and trace element compositions of the surrounding seawater and adjacent sediments. One purpose has been to determine whether the hydrocarbon compositions of seawater or surface sediments reflect the composition of nearby seepage, and can be used to identify previously unknown petroleum sources. The analytical procedures included identification of saturated hydrocarbons by gas chromatography and gas chromatography/mass spectrometry; stable isotopic ratios of sulfur, nitrogen and carbon on gas and oil, and the delta ^{13}C for various liquid-solid chromatographic fractions. The content of nitrogen and sulfur, their isotopic ratios, and the delta ^{13}C of chromatographic fractions, serve to distinguish oils and seeps derived from different formations. Comparison of gas chromatographic/mass spectrometric data from a seep and from a crude oil produced nearby show cycloalkane compositional differences attributable to origins, rather than to differences in weathering history. Data presented demonstrate that analyses of the water column for enrichment in high-molecular-weight hydrocarbons or trace metals adjacent to seep areas may produce equivocal results. Sediment analysis appears to give a more reliable indication of petroleum contribution.

120 Characteristics of thin-skinned style of deformation in the southern Appalachians, and potential hydrocarbon traps. Harris, L.D.; Milici, R.C. Washington, DC; Geological Survey (1977). 44p.

An attempt is made to focus attention on the more important characteristics of the thin-skinned style of deformation in the southern Appalachians by presenting a model to illustrate the regional anatomy of a decollement and to identify likely structures that need additional investigation as possible prospects for hydrocarbon accumulation. Five distinct changes in color of conodonts have been utilized to estimate the oil and gas potential of the southern Appalachians. An Ordovician isograd map suggests that most of the Plateaus, but only a small part of the Valley and Ridge in Tennessee and adjacent parts of Virginia, have a potential for commercial production of oil. The same data, however, show that a much larger area, including most of the Valley and Ridge, has a potential for natural-gas production.

121 Anomalously high strata pressures and their effect on the technique and direction of oil—gas search studies in the Precaspian depression. Kunin, N.Ya.; Bylevskii, G.A. No. 10, 3-17(Oct 1976). (In Russian).

Factual data are presented on individual manifestations of anomalously high strata pressures determined in a number of areas in the eastern and western parts of the Precaspian depression. These data can be considered as signs of a wide dissemination of high-pressure strata zones over the entire, regional hydrodynamic system of the salt depression complex. An analysis of geological-geophysical data shows that high and very high strata pressures have apparently existed under the salt cover in the course of the entire era after the

Kungurski. On this basis, conclusions may be reached about the primary oil composition of the salt hydrocarbons, on the physical and not stratigraphic nature of the seismic reference point, and on the suitability of carrying out deep search drilling on large uplifts of the salt bed over the entire territory of the depression. (SJR)

122 Oil—gas content of local structures in salt-forming basins. Solov'ev, B.A.; Sabaneev, N.S. No. 9, 13-22(Sep 1976). (In Russian).

Salt-forming basins are large, negative structures of the earth's crust, filled with a thick platform covering, which includes salt-bearing formations subjected to processes of salt tectogenesis. In the sedimentary covering of each salt-bearing basin it is possible to distinguish oil-gas complexes: above the salt, intrasalt and below the salt, which show a similarity in structure and oil-gas-bearing conditions. A general classification is presented of productive local structures of oil-gas-bearing complexes in the Precaspian, Dneprovsko-Donetskii and Pripyatskii salt-forming basins. For complexes above the salt a look is taken at structures with faulting of the salt nucleus without breaching and with breaching. For intrasalt and intersalt complexes a characterization is made of block uplifts and structures associated with salt traps. In complexes under the salt a description is given of arch- and domelike uplifts, and block and sedimentation structures. On the basis of the proposed classification an analysis is made of the distribution of primary, extractable, hydrocarbon reserves according to types of local structures, and the most likely traps for oil and gas are indicated. Concrete recommendations are given on searching for hydrocarbon accumulations. (SJR)

123 Genetic unity of above-salt and under-salt oil deposits in the eastern part of the Precaspian depression. Alekseev, F.A.; Bartashevich, O.V.; Krylova, T.A.; Svetlakova, E.A.; Dal'yan, I.B.; Trokhimenko, M.S. No. 9, 108-113(Sep 1976). (In Russian).

By laboratory studies on the isotopic composition of carbon in fractionated oils from above-salt and under-salt deposits in the Kenkiyakskii oil field and from studies on the group composition of these oils it was possible to establish their genetic unity. These data are of great scientific and practical significance in searching for oil deposits in above-salt and under-salt ore complexes. (SJR)

124 Prospects for oil and gas from Silurian—Niagaran trend in Michigan. Yellig, W.F. Jr.; Tek, M.R. Ann Arbor, MI; Institute of Science and Technology (1976). 43p.

Prospects for oil and gas from Silurian-Niagaran Reefs in Michigan have been evaluated. Factual information and data from the matured regions of the Northern Trend Area have been used to develop reserve estimates and predictions applicable to less-developed acreage in the South. Significant results related to size, shape, distribution, location, and recovery prospects were developed and reported. Two concepts reported in the literature, one on "differential migration and selective entrapment,"the other on "analysis of mature areas," were quantitatively supported by data and calculations presented.

125 Testing the program of continuous exploration interpretation of geophysical data in terms of terrygenous section in West-Siberian lowland. Kamyshnikova, L.T.; Bosak, L.A. pp 68-73 of In Izuchenie neftegazonosnykh tolshch Zapadno-Sibirskoj ravniny metodami promyslovoj geofiziki. Moscow; Nedra (1974). (In Russian)

A program is described to determine the continuous curves of the effective porosity, the clay content and the oil saturation parameter of carbonate layers from the data of focussing (induction and lateral) and radioactive (gamma and neutron-gamma log) methods and cavernometry.

126 Interpretation of cementograms. Vokov, Eh.Ya. (Zapadno-Sibirskij Nauchno-Issledovatel'skij Geologorazvedochnyj Neftyanoj Inst., Tyumen' (USSR)). pp 137-140 of In Izuchenie neftegazonosnykh tolshch Zapadno-Sibirskoj ravniny metodami promyslovoj geofizki. Moscow; Nedra (1974). (In Russian)

In order to increase the efficiency and the quality of cement bond log a sufficient difference in the densities of the cement and the solution in the tubing, a hardening time for the cement, the registration of diagrams with calibrated instruments and the use of small probes are necessary.

DRILLING AND PRODUCTION

REFER ALSO TO CITATION(S) 126, 194, 1349

127 (BERC—77/3) Contracts and grants for cooperative research on enhanced oil and gas recovery and improved drilling methods. Progress review No. 11. Linville, B. (ed.). Aug 1977. 117p. Dep. NTIS, PC A06/MF A01.

Short status reports of various enhanced recovery projects sponsored by ERDA are given. The methods include micellar polymer flooding, CO_2 flooding, improved waterflooding, thermal recovery, massive hydraulic fracturing, and chemical explosive fracturing. (LK)

128 (CONF-770836—P1) Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods. Linville, B. (ed.). 1977. 440p. Dep. NTIS, PC A19/MF A01.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

Individual papers were indexed for inclusion in the data base. (LK)

129 (CONF-770836—P1, pp A.1.1-A.1.14) North Burbank Tertiary Recovery Pilot Test. Two-year status report. Kleinschmidt, R.F.; Trantham, J.C.; Boneau, D.F.; Patterson, H.L. (Phillips Petroleum Co., Bartlesville, OK). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

A Phillips/ERDA tertiary pilot test was initiated in May 1975 on a 90-acre tract of the North Burbank Unit using a surfactant/polymer system developed specificaly for this oil-wet reservoir. Phillips is the operator for 18 working interest owners. During the past year the surfactant slug was injected without difficulty and was followed by most of the polymer solution in decreasing stepwise concentrations. The first tertiary oil production was observed early in 1977. By mid-May the tract produced about 185 BPD, over three times the level that would be expected from continued waterflooding. Throughout the chemical injection phases, all injected fluids were monitored for chemical composition and oxygen. Produced fluids were monitored for the appearance of surfactant, alcohol, radioactive tracers, and various inorganic ions. No major operational problems have been encountered. After all the polymer solution has been injected, fresh water will be injected for about two months prior to injecting NBU produced water. Peak production from this tract is not expected until mid-1978. There are insufficient data at this time to confirm the predicted production curve.

130 (CONF-770836—P1, pp A.2.1-A.2.19) Micellar—polymer oil recovery demonstration in the Bell Creek Field, Montana. Goldburg, A. (Gary Operating Co., Englewood, CO). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

Gary Operating Company is conducting an ERDA Pilot Demonstration to determine whether micellar-polymer waterflooding is an economically feasible technique for enhanced oil recovery at the Bell Creek Field, Powder River County, in southeastern Montana. The pilot is a contained 40-acre 5-spot embedded in a representative watered-out part of the field. The net pay is sandstone with average properties: thickness, 8 feet, porosity, 29%, permeability (air) 1050 md, and water TDS of 4000 ppM. The pilot area oil saturation after waterflood available for tertiary recovery is presently evaluated at 35%; and the overall micellar-polymer recovery is estimated at 60%. During the first contract year (July 1976-July 1977), site development began for the demonstration project: pressure pulse tests were conducted across the pilot area; the pilot area wells were drilled, cored and logged; and a new reservoir study was completed. The major effort during the first contract year was the design for the Bell Creek pilot of two competing micellar-polymer processes--one oil-external and one water-external; and the concomitant development of a Selection Methodology by which to decide upon the more suitable process by means of a standard set of laboratory experiments and numerical simulations. This effort is described in detail.

131 (CONF-770836—P1, pp A.3.1-A.3.24) El Dorado Micellar—Polymer Project, El Dorado, Kansas. Miller, R.J. (Cities Service Co., Wichita, KS). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

The El Dorado Micellar-Polymer Demonstration Project is a cooperative venture between Cities Service Company and the United States Energy Research and Development Administration (ERDA). The major field operations during the last twelve months have included injecting preflush in both patterns, conducting pressure transient tests, installing equipment to inject the micellar solution in the South (Hegberg) pattern, conducting injectivity tests for both processes, and initiating injection of the micellar solution in the Hegberg pattern. The primary laboratory work during the year has included making polymer selections, analyzing crude oil related problems, running additional oil recovery flow tests, evaluating injected and produced fluids, analyzing observation well data, and providing support for field related activities.

132 (CONF-770836—P1, pp A.4.1-A.4.24) **Commercial scale demonstration of the Maraflood process: M-1 Project, Crawford County, Illinois.** Knight, B.L. (Marathon Oil Co., Findlay, OH). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

A contract was executed between Marathon Oil Company and the Energy Research and Development Administration (ERDA) on September 30, 1976, for the purpose of conducting a commercial scale demonstration of enhanced oil recovery by micellar-polymer flooding. The demonstration is known as the M-1 Project. It encompasses 407 acres of Main Consolidated (Robinson) Sand reservoir in Crawford County, Illinois. The project cost at contract initiation was estimated to be approximately $43,560,000, with total ERDA funding of $14,000,000. The contract covers ten years of the 15-year project life. Field development, including well drilling and completion and surface facility installation, was essentially complete when the contract was negotiated. Following fluid system design, optimization and fluid injectivity testing, micellar solution injection into the project commenced as scheduled on February 10, 1977. Project operation has continued routinely since that time.

133 (CONF-770836—P1, pp A.5.1-A.5.9) **Bradford Sand Micellar—Polymer Flood, Bradford, Pennsylvania.** Danielson, H.H.; Paynter, W.T. (Pennzoil Co., Bradford, PA). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

The Pennsylvania Grade Crude Oil Association in conjunction with the Energy Research and Development Administration is conducting a twenty-four acre field test to demonstrate the efficiency and economics of recovering tertiary oil from a depleted waterflood in a low permeability Bradford Third Sand reservoir. The enhanced recovery technique being used is a micellar-polymer process. During the year, forty-one wells were drilled and completed for the nine five-spot pattern test. The core and log data obtained during the development were used in the laboratory to design the process and to determine the pore volume of the reservoir. A transient test program to determine the anisotropic properties of the reservoir was completed prior to May 20, 1977, when pre-slug brine injection was initiated. During the pre-slug injection, certain additional step-rate pressure tests will be conducted to further evaluate reservoir properties. Upon completion of brine injection in August, 1977, a micellar slug will be injected and displaced by a biopolymer-water solution.

134 (CONF-770836—P1, pp A.6.1-A.6.15) **Micellar—Polymer Joint Demonstration Project, Wilmington Field, California.** Wade, J.E. (Department of Oil Properties, Long Beach, CA). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

The City of Long Beach entered into a contract with the Energy Research and Development Administration July 7, 1976, to conduct a joint demonstration project of Micellar-Polymer flooding to develop improved oil recovery techniques which would be applicable to the extensive unconsolidated oil sands of the California Coastal Zone. The site selected for the test consists of approximately 10 acres located in the watered-out area of an old peripheral waterflood in the HXa sand of Upper Terminal VB. Test pattern model studies of streamline flood fronts indicate the best of seven patterns studied is a W-E staggered line drive consisting of 4 injectors and 6 producers. Radial core floods conducted by Marathon Research Center tested a number of Micellar-Polymer systems using reservoir rock and fluid samples taken from nearby wells. These tests confirmed that substantial additional oil was recoverable after depletion by waterflooding. Residual oil saturations of 7 to 10% pore volume have been obtained from slugs made up of several different, commercially available sulfonates. Work is in progress to test sulfonates made from Wilmington crude oil or local refinery stocks. Early tests of polymers indicated a problem of reactivity with the reservoir rock, however, core floods with the micellar-polymer systems did not exhibit this problem. Additional core floods are planned on fresh cores recently obtained from the pilot area. Surface facilities have been designed and construction is under way. The first well FT-1 was spudded June 25, 1977. Cores were taken by plastic sleeve core barrel and frozen on location for later use in Phase B radial core flooding. A mini-injection test will be undertaken which will include pressure transient testing. Slug injection is expected to commence mid-year 1978.

135 (CONF-770836—P1, pp A.7.1-A.7.11) **ERDA's Micellar-Polymer Flood Project in northeast Oklahoma.** Thomas, R.D.; Walker, C.J.; Burtch, F.W. (Bartlesville Energy Research Center, OK). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

ERDA's Bartlesville (Oklahoma) Energy Research Center is conducting a micellar-polymer flood in the Delaware-Childers field in NE Oklahoma. The test site is a 2 1/2-acre inverted five-spot with twinned, central injection wells and eight surrounding water-injection wells. The producing horizon is the Bartlesville sand, having net thickness of 52 ft at a depth of 620 to 700 ft, an average permeability 100 md, and an average porosity of 21 percent. The estimated oil saturation is 32 to 36 percent of 33° API gravity oil. The sand was determined to be oil wet. The three-phase injection program consists of a 0.1-PV saline preflush, a 0.1-PV micellar slug and 0.4-PV mobility-control buffer. The micellar formulation was a commercial blend of petroleum sulfonates and an alcohol cosolvent in brine with no added hydrocarbon. The mobility buffer is a tapered slug of a partially hydrolyzed polyacrylamide in dilute brine. Pressure and flow are monitored instrumentally at the injection wells. Spot checks for the quality of injected and produced fluids are made by chemical analysis. Injection of micellar fluid was started on April 28, 1976, following 5 months of brine preflush. Micellar injection was completed and polymer injection started Oct. 5, 1976. Calculations based on laboratory results and reservoir properties indicate that the total recovery should be 50 percent of the estimated 70,000 bbl of oil in place. Current injection and production history along with field problems and solutions is discussed.

136 (CONF-770836—P1, pp A.8.1-A.8.13) **Ultralow interfacial tension, phase behavior and chemical flooding processes for improved petroleum recovery.** Davis, H.T.; Scriven, L.E. (Univ. of Minnesota, Minneapolis). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

A coordinated experimental and theoretical attack is under way at Minnesota on basic mechanisms of surfactant-based petroleum recovery processes and related fundamental questions about interfacial tension, phase behavior, rate effects and displacement processes in porous media. One goal is principles of selection or design of surfactant systems for enhanced recovery from a given reservoir. The questions are of both practical and scientific relevance and are eminently suitable for the thesis-connected academic research and education which are the Minnesota department's main mission. Results to date, including those published in 20 papers, 3 Ph.D theses and 3 M.S. theses, are highlighted in the following categories: molecular theories of phase behavior and tension in surfactant and related systems, thermodynamic theory and modeling, experimental studies of phase behavior and structure, measurements of interfacial tension, percolation theory of flow processes in porous media, mechanics of residual phase blobs, experimental studies by flow visualization, capillary number correlation of residual nonwetting phase, theory and modeling of one-dimensional miscible, semimiscible and immiscible displacement processes. Results also include alumni transferred either temporarily or permanently to companies engaged in advanced petroleum recovery processes or chemical manufacture for these processes.

137 (CONF-770836—P1, pp A.9.1-A.9.7) **Structure of solutions of synthetic petroleum sulfonates before and after addition of oil.** Benton, W.J.; Hwan, R.; Miller, C.A.; Fort, T. Jr. (Carnegie-Mellon Univ., Pittsburgh). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

The polarizing microscope was used to study numerous aqueous solutions of two synthetic petroleum sulfonate surfactants. Structure was observed as a function of surfactant concentration, salt concentration, temperature, and time. Liquid crystalline material was seen in various structures in these solutions. Time-dependent transformation between structures was also observed. When oil was added to these systems, microemulsions were formed. The ultracentrifuge was used to measure drop size as a function of system composition for both oil-continuous and water-continuous solutions of one surfactant. The surfactant phase was also studied and found to be oil-continuous for some conditions, water-continuous for others, and not a simple dispersion of one phase in another for still other conditions.

138 (CONF-770836—P1, pp A.10.1-A.10.5) **Low interfacial tension behavior of pure sodium alkylbenzene sulfonates.** Doe, P.H.; El-Emary, M.M.; Morgan, J.C.; Wade, W.H.; Schechter, R.S. (Univ. of Texas, Austin). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

Several linear alkylbenzene sulfonates (LABS), LABS's with additional alkyl substituents, di- and trialkylbenzene sulfonates, and tetralin sulfonates have been synthesized and their interfacial tension properties have been studied. Qualitative similarity in behavior was found for these surfactants, but each class was found to prefer a different portion of the alkane series for lowest tensions. Differences were also found in the absolute magnitude of the minimum tensions obtainable, as well as in the degree of their salinity tolerance.

139 (CONF-770836—P1, pp A.11.1-A.11.19) **University of Florida research program on chemical oil recovery systems.** Shah, D.O.; Walker, R.D. Jr.; O'Connell, J.P.; Gordon, R.J.; Schweyer, H.E. (Univ. of Florida, Gainesville). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

The improved oil recovery research program at the University of Florida is a multidisciplinary research program designed to elucidate various interactions occurring between injection fluids such as surfactant and polymer solutions, and reservoir components such as clays, minerals, oils, and sand. The following are the five major areas of research of this program: (1) Interfacial Phenomena, (2) Bulk, Surface and Porous Media Rheology, (3) Adsorption and Ion Exchange Phenomena, (4) Polymer Rheology and Fluid Mechanics, and (5) Thermodynamic Phenomena and Phase Equilibria. The research program is designed to establish a broad framework of information relating the microstructure of injection fluids and their behavior in porous media to oil displacement efficiency. It is hoped that the development of the basic framework of new information and the quantitative relationships among various parameters of the process would assist industry in developing, optimizing and fine tuning of injection fluids for reservoirs of varying conditions. Our accomplishments of the past one year in each of these areas are reviewed.

140 (CONF-770836—P1, pp A.12.1-A.12.6) **Large-scale (laboratory) samples of sulfonates for tertiary oil recovery: preparation and related studies.** Malmberg, E.W. (Suntech, Inc., Richardson, TX). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

Sun Company has agreed with the Energy Research and Development Administration to prepare samples of a range of hydrocarbon sulfonates that are of potential value for tertiary oil recovery. Samples will be made available for laboratory studies to interested groups in academic, government, and industry laboratories. As a result of this work, a systematic review will have been made of the streams of a representative modern refinery and of petrochemical materials in order to search out and devise reasonable candidates as sulfonation stock for the production of tertiary recovery surfactants. The sulfonates will be related to refinery streams so that large-scale availability can be projected as accurately as possible. The contract is just now in effect, and the preliminary studies are being made of products from selected refinery streams. Sun is not to derive any advantage from this program, so that arrangements for samples, information on the samples, and information developed during the program on the properties of the sulfonates will be handled by Dr. J.T. Taber of the New Mexico Petroleum Recovery Research Center, New Mexico Tech, Socorro, New Mexico. Suggestions from any candidates for the program or other aspects may be sent to him. To realize the maximum benefit from this program, it is hoped that the sharing of nonproprietary information as expeditiously as possible will further facilitate current research on enhanced oil recovery.

141 (CONF-770836—P1, pp A.13.1-A.13.25) **Enhanced oil recovery research in the university, energy research center, national laboratory community.** Maier, R.H. (Gulf Universities Research Consortium, Houston, TX). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

Descriptions of enhanced oil recovery research projects were prepared and input to a data base for computer analysis. Research topics covered by the projects were then correlated to research topics recommended by a workshop on enhanced oil recovery attended by 113 individuals from academic institutions, industrial organizations, and Federal and State agencies. The results show that the analytical characterization of research projects is practical and that an ongoing inventory will provide a valuable tool for the planning, management, and assessment of a multi-disciplinary, multi-institutional, coordinated research program.

142 (CONF-770836—P1, pp B.1.1-B.1.17) **Polymer enhanced waterflooding: a status report of the North Stanley Project, Osage County, Oklahoma.** DuBois, B.M.; Johnson, J.P.; Cunningham, J.W. (Kewanee Oil Co., Tulsa, OK). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

The North Stanley Project is a jointly funded project between Kewanee Oil Company and the Energy Research and Development Administration. The object of this project is to determine if additional oil can be recovered from a highly heterogeneous reservoir that is nearing its economic limit by using a polymer slug to improve sweep efficiency. Preparation of the project for polymer injection included a reservoir analysis, an injection well workover program, the installation of polymer mixing equipment, and the stabilization of production prior to commencing polymer injection. Injection profile surveys and pressure fall-off tests were run prior to initiating polymer injection to aid in evaluating the subsequent effect of polymer on the reservoir. Also, a four month fresh water preflush was run ahead of the polymer to act as a tracer fluid. During this preflush, the producers were tested on a weekly basis for fresh water dilution. This testing revealed two instances where fluid was directly transmitted through natural fractures to producers. Injection of Dow Pusher 700 was commenced on June 16, 1976, and was completed on June 22, 1977. During this time, 1,194,770 lb of Pusher 700 was injected. Injection well testing continued during polymer injection with two series of injectivity profiles and pressure fall-off tests being run. Producers were tested on a regular basis for fresh water dilution and concentration of produced polymer. This information will be especially important in evaluating polymer related changes in sweep efficiency.

143 (CONF-770836—P1, pp B.2.1-B.2.18) **Caustic Waterflooding Demonstration Project, Ranger Zone, Long Beach Unit, Wilmington Field, California.** Carmichael, J.D. (City of Long Beach, CA); Alpay, O.A. 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

A caustic-enhanced waterflooding pilot test is being initiated in the Ranger Reservoir of the Long Beach Unit, Wilmington Field, California, by the Department of Oil Properties of the City of Long Beach and the Field Contractor, THUMS Long Beach Company in association with ERDA. A unique combination of two alkaline flood processes will be attempted for the first time to increase recovery efficiency. A 95-acre area, consisting of 11 producers bracketed by two 4-well injection rows and two major faults, has been selected for the pilot. During the initial phase of the project, a dilute solution of caustic will be injected in softened fresh water to emulsify the reservoir crude and improve conformance by the "emulsion entrapment" process. This phase will be followed by injection of a dilute solution of caustic in softened water containing salt to "entrain" the emulsified oil, hence to improve displacement efficiency. Preliminary site preparation, facilities design and installation work are nearing completion. Further laboratory investigation of the two caustic processes using native-state cores is continuing. A preliminary, small scale injectivity test of two-months' duration using the planned test chemicals was started in early June, 1977, in one of the pilot area injectors.

144 (CONF-770836—P1, pp B.3.1-B.3.13) **Coalinga Demonstration Project: oil recovery by polymer flooding.** Tinker, G.E.; Tixier, C.E.; Montague, D.R.; Bowman, R.W.; Swarbrick, J.C.; Bates, T. 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

The Coalinga Polymer Demonstration Project is a jointly funded venture between the Shell Oil Company and the United States Energy Research and Development Administration that was initiated to test polymer flooding as an enhanced oil recovery method in the East Coalinga field of California. Water injection started for the project June 28, 1976, in a program to determine if the added expense of a polymer flood over a conventional waterflood is justified. Potential supplemental oil recovery from Shell's Temblor Zone II reservoir in the Coalinga field is 35,000,000 barrels which includes 8,000,000 from polymer injection. The Water Injection Phase has been underway for about one year, and it will continue until a reliable prediction of waterflood performance can be made. Because there has been a lack of a clearcut waterflood response for the project, polymer injection will be delayed until the waterflood base case has been determined. There is a program underway to improve waterflood response so that polymer injection is expected to start during 1978.

145 (CONF-770836—P1, pp B.4.1-B.4.14) **Mechanism of oil bank formation and coalescence in porous media.** Wasan, D.T.; Shah,

S.; Aderangi, N.; Chan, M.; McNamara, J.J.; Paolicchi, R.; Patel, P.; Mohan, V. (Illinois Inst. of Tech., Chicago). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

A study has been initiated which would provide a method for predicting the range of coalescence behavior in oil bank formation, development and emulsion stability for crude oil-surfactant systems during enhanced oil recovery processes. The recent results of this study have included the development of apparatus for coalescence studies and an interference phase contrast technique combined with high resolution optical sectioning for the determination of the thickness of the surfactant films surrounding emulsified oil droplets. Cinephotomicrographic observations of crude oil emulsions in aqueous solutions of petroleum sulfonate are reported. New insight has been gained into the interrelationships of coalescence behavior with interfacial viscosity, interfacial tension, interfacial charge, structure and the thickness of the surfactant films. The role of co-surfactants in destabilizing these emulsions is highlighted. A preliminary correlation between coalescence rates and these properties which can provide guidelines for the selection of surfactants, co-surfactants and other chemical additives for the optimization of oil recovery in tertiary oil recovery processes has been attained. Based on the information gathered in this phase of the program, experiments are being designed to compare oil bank formation and oil recovery in simple visual micromodels and in laboratory cores.

146 (CONF-770836—P1, pp B.5.1-B.5.19) **Enhanced recovery with mobility and reactive tension agents.** Radke, C.J.; Somerton, W.H. (Univ. of California, Berkeley). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

Recovery efficiencies of acidic California crude oil and synthetic mineral oils by in-situ surfactant generation with dilute aqueous bases are investigated to elucidate the criteria necessary for tertiary oil production. The project includes studies on displacement dynamics, interfacial tensions, emulsion physical chemistry and emulsion rheology. Core displacements to date indicate complicated ranges of behavior including spontaneous emulsification, emulsion coalescence and emulsion inversion with subsequent entrapment or entrainment depending in part on the oil acid content and the aqueous pH and ionic strength. However, tertiary-mode recovery efficiencies of 50 percent can be attained by careful adjusting of pH and salt concentration. Spinning drop "dynamic" interfacial tensions of oil against caustic significantly increase in time indicating the difficulty of maintaining low tensions during flooding. A phenomenological model is presented for the porous media rheology of stable emulsions containing large drop size to pore size ratios. This model, which is based on principles gleaned from the theory of deep-bed filtration, correctly predicts the large, unsteady and flow-rate-dependent permeability reductions observed in core experiments. Presently this work shows that high pH flooding of acidic oils can recover significant amounts of tertiary oil but because of the wide scope of recovery mechanisms careful chemical tailoring is required.

147 (CONF-770836—P1, pp B.6.1-B.6.5) **Effect of surface viscosities in the recovery of residual oil by displacement.** Slattery, J.C. (Northwestern Univ., Evanston, IL). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

A major objective of this project has been to develop a quantitative estimate for the effects of the surface viscosities during displacement. We are currently developing the first stage of a detailed solution for displacement within a single pore including the effects of the surface viscosities. We have completed an analysis of interfacial effects in the displacement of residual oil by foam. The predicted effects of the surface viscosities are in agreement with those observed experimentally by Kanda and Schechter. This gives added support to the predictions of a similar analysis regarding the effects of the interfacial viscosities in the recovery of residual oil by surfactant waterflooding.

148 (CONF-770836—P1, pp B.7.1-B.7.11) **Measurement of dynamic interfacial properties using a drop deformation methods: theoretical extensions.** Flumerfelt, R.W. (Univ. of Houston, TX). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

Various improvements have been made in the theoretical foundations for the measurement of dynamic interfacial properties from observations of drop dynamics (deformation, circulation, etc.) in simple shear fields. In particular, a theory valid at small shear rates has been obtained which accounts for interfacial tension gradients (ITG) arising from spatial variations of surfactant concentration. The results from such a theory clearly indicate the relative roles played by ITG and interfacial rheology in drop deformation and circulation experiments in simple shear fields, and suggest conditions under which intrinsic interfacial viscosity measurements may be possible from such tests. Separate from these developments, we have also obtained a hydrodynamic solution for deformation and circulation valid for small deformations, but large shear rates; the latter condition being possible for fluid systems where the effective viscosity ratio, drop phase to continuous phase, is greater than 3.5. Experimentally, such results are attractive since (1) ITG effects become relatively unimportant at high shear rates, and (2) measurements of interfacial viscosities at these conditions do not require a knowledge of the equilibrium interfacial tension. In what follows, the important results of these theoretical developments are summarized, and their implications with respect to intrinsic interfacial viscosity measurements are discussed. Experimental observations are presented to check the interpretations and provide some verification of the experimental approaches which are suggested.

149 (CONF-770836—P1, pp B.8.1-B.8.13) **Effect of frontal advance rate on oil recovery by micellar-polymer displacement.** Sayyouh, M.H.; Farouq Ali, S.M.; Stahl, C.D. (Pennsylvania State Univ., University Park). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

The principal objective of this work was to investigate the effect of rate on oil recovery from linear consolidated cores by micellar slugs driven by suitable mobility buffers. The oil recovery was found to be rate-dependent under these conditions. Most of the displacements were carried out at frontal advance rates as low as 0.1 foot per day. In this range, results of some 26 runs conducted indicate that the recovery tends to decrease with rate (e.g., 60.7 percent at 4.35 ft/day vs. 43.0 percent at 0.94 ft/day in a 4-ft. core), up to a point and tends to increase thereafter (e.g., 54.4 percent at 0.50 ft/day). This latter finding is new and a theory to explain this behavior is developed. Another goal of this research was to determine if displacements in 2-ft and 4-ft long cores are comparable. On the basis of the runs conducted, this seems to be so. Finally, results of a few runs show that oil recovery by micellar solutions is slightly greater in vertical than in horizontal flow tests.

150 (CONF-770836—P1, pp B.9.1-B.9.15) **Enhanced oil recovery by micellar floods: chemicals from wastes, tracers, and ion-exchange aspects.** Johnson, J.S. Jr. (Oak Ridge National Lab., TN). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

Work in support of enhanced oil recovery, primarily by the micellar-flood approach, is ongoing in three areas at the Oak Ridge National Laboratory. In the first program, underway for over a year, cheap raw materials for chemicals are sought, primarily in waste streams and natural products. Emphasis so far has been on hardness-control agents and on surfactants from wood-pulping wastes, primarily from the kraft process, and on mobility control polymers. The fungus Sclerotium rolfsii has received considerable attention for production of biopolymers from cheap carbon sources, because of favorable characteristics of polymer produced, nutrient requirements, and fermentation conditions. The second program, still in its early months, will deal eventually with more general ion-exchange properties of minerals, surfactants and other pertinent chemicals, and their combinations. Initially, base-line information is being sought, for example, on alkali metal-alkaline earth equilibria between aqueous solutions and montmorillonite and on phase behavior of brine-hydrocarbon systems, with added compounds which may be related chemically to cosurfactants or which may be model surfactants, such as aromatic sulfonates, but are lacking the long hydrocarbon chains typical of surfactants. The third program, also in its early stages, involves a search for new (inorganic) tracers to monitor progress of the various aqueous banks involved in enhanced recovery. We plan to measure distribution of potentially useful ions between aqueous phases of a wide range of salinities including those found in oil-field brines, and a few solids representative of formation minerals. The aim is to identify conditions under which adsorption of the various tracers might be weak enough to make them useful for this application.

151 (CONF-770836—P1, pp B.10.1-B.10.8) **ERDA in-house research on thermodynamics of oil-recovery micellar systems.** Berg, R.L.; Noll, L.A.; Good, W.D. (Bartlesville Energy Research Center, OK). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

Interactions of micellar solutions with cosurfactants and brine are being studied calorimetrically. Large effects due to alcohol chain structure and concentration are observed. In addition, there is a strong temperature dependence for the micellar systems. An adsorption calorimeter has been assembled and is being used in a study of the interactions with clay and sand surfaces.

152 (CONF-770836—P1, pp B.11.1-B.11.8) **Measurement of interfacial tension by the rod-in-free surface meniscal breakoff method: II.** Kovitz, A.A.; Yannimaras, D. (Northwestern Univ., Evanston, IL). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

Low tension systems result in small meniscal breakoff heights (in the order of 10^{-3} cm for 10^{-3} dynes/cm). Detection of the meniscal breakoff by interruption of an electrical signal proved dependent on interface age; as aging occurred signal interruption became inconclusive, correlating with the appearance of a "third phase" at the interface. An improvement in breakoff detection was achieved by using the pressure above the meniscus as an indicator. With breakoff this pressure suddenly rises and is easily observed on a strip-chart recorder. Analysis shows that accurate measurement of the pressure vs interface traverse distance relative to the fixed contact piece gives all the necessary data for obtaining the apparent interfacial tension. To date we have been able to detect arbitrarily small breakoff heights in this manner; as yet the sufficiently accurate pressure measurement has not been achieved. However, with a previously determined interface "zero position" low tension systems have been measured. These measurements are being compared with in-house spinning drop data. The results are in fair agreement insofar as ultimate values for interfacial tension are concerned; but the time-wise behavior is radically different. Furthermore, the final spinning drop shape is often not in accord with theoretical predictions. Further work on comparison of meniscal breakoff and spinning drop results is proceeding. Of particular interest is the effect of mass (surfactant) transfer to the interface.

153 (CONF-770836—P1, pp C.1.1-C.1.5) **West Virginia CO_2 oil recovery project interim report.** Beeler, P.F. (Guyan Oil Co., Huntington, WV). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

The Griffithsville Field, Berea Sand pilot liquid CO_2 enhanced oil recovery project is well underway. The pilot reservoir area, found to be water invaded due to dump flooding after abandonment, was rapidly brought to a pressure adequate to maintain CO_2-oil miscibility. Weather, environmental problems and difficulties encountered reworking many old abandoned wells set back the project timetable.

154 (CONF-770836—P1, pp C.2.1-C.2.9) **Granny's Creek CO_2 Injection Project, Clay County, West Virginia.** Conner, W.D. (Columbia Gas Transmission Corp., Charleston, WV). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

Columbia Gas Transmission Corporation, in conjunction with the Energy Research and Development Administration is conducting a field demonstration of oil recovery by CO_2 injection in Clay County, West Virginia. The objective of this test is to evaluate and demonstrate the effectiveness of using CO_2 injection to recover high gravity crude oil from shallow watered-out reservoirs. The estimated recovery potential from the 6.5 acre flood pattern is approximately 50,000 barrels. The reservoir was repressured to approximately 1000 psi with water prior to CO_2 injection. The plant was completed and CO_2 injection began on June 2, 1976. The CO_2 slug was injected in several stages, alternating with water periodically for mobility control, and better sweep efficiency. Through July 11, 1977, approximately 6050 barrels of additional oil have been recovered due to CO_2 injection.

155 (CONF-770836—P1, pp C.3.1-C.3.15) **Development of a pilot carbon dioxide flood in the Rock Creek-Big Injun Field, Roane County, West Virginia.** SanFilippo, G.P. (Pennzoil Co., Vienna, WV); Guckert, L.G. 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

The Rock Creek Field, discovered in 1906, is the site of a pilot carbon dioxide flood designed and installed by Pennzoil Company with financial support from ERDA. Favorable reservoir characteristics and conditions, the inability to successfully stimulate production by conventional waterflooding, and the fact that nearly 150,000,000 barrels of oil will remain in the reservoir after completion of the low pressure gas recycles now in operation were the main factors responsible for the initial study of miscible fluid displacement by carbon dioxide injection. After laboratory tests indicated the reservoir oil and carbon dioxide to be miscible at a reasonable pressure, the design and installation work for the pilot was initiated. Currently in the water injection or pressure build-up phase, the project has progressed satisfactorily with injection of carbon dioxide scheduled for early 1978.

156 (CONF-770836—P1, pp C.4.1-C.4.9) **Weeks Island "S" Sand Reservoir B: gravity stable miscible CO_2 displacement, Iberia Parish, Louisiana.** Perry, G.E. (Shell Oil Co., New Orleans). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

Shell Oil Company in conjunction with the Energy Research and Development Administration is preparing to conduct a gravity stable displacement test of the miscible CO_2 process. This tertiary field test will be in a steeply dipping, high temperature and high pressure Gulf Coast reservoir. A 50,000-ton CO_2 slug will be injected into an existing well at the original gas-oil contact and displaced downdip to a new producing well. The eight-acre pilot area is bounded laterally and downdip by faults and updip by intersection with a salt dome. Gravity forces will be utilized to maintain slug integrity between the displaced oil bank and the overlying gas cap. The downward displacement will be controlled by the quantity of water produced from a downdip well.

157 (CONF-770836—P1, pp C.5.1-C.5.10) **Carbon dioxide supply situation for miscible flooding operations.** Porter, R.E.; Cover, A.E. (Pullman Kellog, Houston, TX). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

Pullman Kellogg, with assistance from Gulf Universities Research Consortium (GURC), is studying the carbon dioxide supply situation for miscible flooding operations to enhance oil recovery. Candidate oil reservoirs have been identified. The carbon dioxide requirements and the potential recoverable oil for some of these have been estimated. A survey of carbon dioxide sources has been conducted within the geographic areas where candidate oil reservoirs exist. Sources considered were both high and low quality gases from combustion vents, chemical process stacks, and naturally occurring gas deposits. Systems to purify and deliver the carbon dioxide have been designed and the costs of the delivered carbon dioxide estimated.

158 (CONF-770836—P1, pp D.1.1-D.1.11) **Bodcau In Situ Combustion Project, Bossier Parish, Louisiana.** Joseph, C. 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

The objective of this contract is to demonstrate the efficiency and economics of a simultaneous water-air in situ combustion process. Contract period extends from June 1, 1976 through June 30, 1982.

159 (CONF-770836—P1, pp D.2.1-D.2.14) **Development and field testing of the Vapor Therm process, Iola, Kansas.** Sperry, J.S. (Carmel Energy, Inc., Houston, TX). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

Carmel Energy entered into an 18-month cost sharing contract with ERDA in April 1976 to demonstrate the commercial applicability of the Vapor Therm Process on the Clinkenbeard lease in Allen County near Iola, Kansas. A new full-size Vapor Therm unit which generates a mixture of steam, nitrogen and carbon dioxide at 900 psig and 650°F was designed and built to applicable ASME codes. Four new wells were drilled and completed in the Bartlesville sand. These wells and one previously drilled well are in a 2 acre five-spot pattern with each well 208.7 ft. from the center well. Primary production data were taken on each well from completion date through mid-December 1976. On January 31, 1977, the first stimulation was started and continued until February 10, 1977. The new Vapor Therm unit and all auxilliary equipment operated as designed. Following stimulation, the wells were put into production. Initial production was 62 BOPD, declining to 10 BOPD over an eight week period. The second stimulation began on April 2 and continued for 4 days with four wells being stimulated simultaneously. An emulsion destabilizer was added to the inert gas/steam mixture prior to injection into the wells. Production peaked at 103

BOPD, then declined to 20-25 BOPD after eight weeks. Two more stimulation/production cycles are planned prior to completion of the ERDA contract September 30, 1977.

160 (CONF-770836—P1, pp D.3.1-D.3.14) **Willow Draw Field Attic Air Injection Project, Park County, Wyoming.** Wilson, Q.T. (Oil Development Co. of Texas, Amarillo). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

ODCOT, in conjunction with ERDA, is conducting a field trial of ATTIC AIR INJECTION in the Willow Draw Field, Park County, Wyoming. The subject reservoir is a small classic anticline of heavily fractured carbonate with low matrix perm underlain by an infinite, fully active acquifer, and filled with 13 to 16° API heavy crude. Primary recovery under these conditions was projected at 1 percent of OOIP. The subject test has a dual objective: (a) To regress the water influx by balancing cumulative production and withdrawals of oil with attic air injection, thus reducing WOR, increasing oil rates, and displacing trapped attic fracture oil down for recovery by producing wells, and (b) To test feasibility of improving recovery of matrix oil in this type reservoir by a gravity powered gas/oil interchange along the face of gas filled fractures. Air injection started May 1975, but continuous effective injection was not implemented until December 1976. Results to date are encouraging and in general conformance with theoretical predictions, but not conclusive.

161 (CONF-770836—P1, pp D.4.1-D.4.9) **Steamflood of heavy oil, Cat Canyon Field.** Hanzlik, E.J.; Schenck, H.; Birdwell, B.F. (Getty Oil Co., Ventura, CA). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

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A 20-acre pilot demonstration steamflood is being conducted by Getty Oil Company in the Cat Canyon Field, Santa Barbara County, California. Continuous steam injection into the four inverted five-spot pilot patterns was initiated in April 1977, after lengthy delays in obtaining steam generator permits. The nine producing wells are being cyclically steam stimulated to improve mobility of the 9° API gravity oil prior to steam breakthrough from the injectors. Steam stimulation performance of the producing wells and initial steam injection well performance are discussed. Estimated ultimate recovery from the project is 850,000 barrels of oil.

162 (CONF-770836—P1, pp D.5.1-D.5.12) **Wet combustion pilot, Paris Valley Field, California.** Patek, J.W.; Meldau, R.F. (Husky Oil Co., Santa Maria, CA). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

Husky Oil Company with ERDA support is operating a 23 well wet combustion pilot in the Paris Valley Field, California. The objective is to develop an economic thermal recovery process for wells which initially produce less than 1 BOPD of very viscous oil. Cyclic steam stimulation gives peak oil rates up to 200 BOPD in some wells, but the rate usually drops sharply after two to four weeks even through the wellhead producing temperature is above 200°F and declining slowly. Total lease oil production from cyclic steaming averages 160 barrels per calendar day during the first five months of 1977. A combustion test in one pattern last year showed good air injectivity and flow to all surrounding producers. Full-scale air injection started in May 1977.

163 (CONF-770836—P1, pp D.6.1-D.6.12) **"200" Sand Steamflood Demonstration Project.** Alford, W.O. (Chanslor-Western Oil and Development Co., Santa Fe Springs, CA). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

A test of steamflooding to improve recovery of 11°API, 6,500 CPS oil from the Spellacy Formation is being conducted in four 2.35-acre inverted seven-spot steam drive patterns in the Midway-Sunset Field, Kern County, California. This pool, designated the "200" Sand, contains approximately 50 million barrels of oil-in-place in an anticlinal structural feature between 400 and 700 feet in depth. The reservoir did not yield any primary production and responded unfavorably to cyclic steam stimulation, which is the principal recovery technique normally used to produce the tar-like crude in this area. Within the four patterns are two interior wells with two different methods of completion that will be key wells for determining production response for expanding the project. The project, which was commenced during the latter part of 1975, is now in the final work plan under Phase I. Continuing evaluation of the production response, economics, and reservoir data are being made to decide the merits of a continuation into Phase II of this project. Phase II will consist of expanding to the full-scale project of 14 inverted seven-spot patterns.

164 (CONF-770836—P1, pp D.10.1-D.10.9) **ERDA in-house research on stimulating heavy oil recovery by in situ combustion.** Johnson, F.S. (Bartlesville Energy Research Center, OK). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

The Bartlesville (Okla.) Energy Research Center, ERDA is studying petroleum-recovery techniques for the many low-productive, heavy-oil sand deposits located throughout the United States. One of the recovery methods being studied is in-situ combustion. Modification of the basic in-situ combustion techniques are necessary because of the low permeability sand, high viscosity oil, and lack of internal energy of some of these reservoirs in the Mid Continent area. Laboratory tests have been conducted on reservoir cores from a selected field test site in Labette County, Kansas involving burning through a fractured core. These tests show that with a small fracture width a fire can be sustained through a fractured core. Some results of the laboratory tests are given along with the current status and plans for a field test.

165 (CONF-770836—P2) **Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.** Linville, B. (ed.). 1977. 314p. Dep. NTIS, PC A14/MF A01.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

Individual papers were indexed for inclusion in the data base. (LK)

166 (CONF-770836—P2, pp H.7.1-H.7.6) **True fluid coring.** Ward, C.E.; Sinclair, A.R. (Maurer Engineering Inc., Houston, TX). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

Secondary and tertiary recovery programs are very expensive to initiate and maintain and careful evaluation of every reservoir being considered is necessary. Unfortunately, current formation evaluation techniques do not provide accurate enough fluid content information to permit sound economic decisions. The ERDA Fossil Fuels Division funded a study to analyze the problem and to identify feasible alternative solutions. The problems and solutions are reviewed and a feasible Phase I system, which would provide acceptable information accuracy under many conditions, is described. The design of this system is currently being funded by ERDA.

167 (FEA/B—77/334) **Potential and economics of enhanced oil recovery update report.** Nov 1976. vp. Energy Administration, Washington, DC.

The U.S. government has set as national policy the reduction of dependence on imports, consistent with other valued goals, e.g., economic recovery, sustained growth, and environmental protection. One of the steps in implementing this policy was the passage of the Energy Policy and Conservation Act (EPCA) which provides for additional incentives for tertiary oil recovery. FEA's mandated responsibilities require that it: (1) estimate the potential of EOR to supplement domestic petroleum supply; (2) determine what portion of this potential will be developed and produced during the critical period of high reliance on imports; (3) design alternative regulatory and economic incentive programs to achieve the potential of enhanced oil recovery; (4) select and carry out the programs that offer to stimulate maximum production during the period of critical shortage, consistent with cost-effective use of public funds. This study is to assist FEA in planning and carrying out these tasks. This support takes the form of analyses of the current status of the technology, and projections of industry's performance if stimulated by an FEA economic incentive program.

168 (ORNL/MIT—252) **Dispersion of miscible fluids in packed columns.** Chen, Z.P.; Cherry, R.S.; Eagleton, J.C. 25 Apr 1977. Contract W-7405-ENG-26. 27p. Dep. NTIS, PC A03/MF A01.

The effect of packing size, fluid velocity, density difference, and the viscosity ratio between displacing and displaced fluids on the stability of the displacement front were investigated in a 50-ml column packed with two types of sand and glass beads. The miscible displacing and displaced fluids were ethanol/water mixtures pumped through the column at 0.4 to 2.0 ml/min. Stable displacements occurred for all but seven of the conditions investigated. Dispersion coefficients calculated for these stable displacements ranged from 4×10^{-5} to 4×10^{-3} cm^2/s.

169 **Petroleum and oil prospects on the east coast of India.** Krishnaswamy, S.S. 15: No. 10, 22-35(Oct 1976).

Development of oil finding techniques is reviewed followed by an appraisal of oil prospects on the Indian east coast. Notwithstanding the poor success which attended the earlier efforts to locate suitable oil-bearing structures by drilling on the on-shore areas of the east coast of India, sustained efforts should be now made in a systematic manner, especially in the wake of finding oil and coal in the North Sea and of success in finding oil in Bombay High (which is some 160 kms north-west of Bombay in the Arabian sea), to survey off-shore areas in detail to locate possible oil-bearing structures. However based on knowledge and experience of conditions of oil occurrence elsewhere in the world it may be worthwhile to drill a few wild cat wells and with this view locations are suggested primarily to learn and understand the underground geology and structure of the offshore areas on the east coast of India and incidentally to strike any oil-bearing structures and horizons present there.

170 Application of the EhRI-1 electric spark radioisotope injector for exploring holes filled with mineralized water. Zabrodin, P.I.; Chernyshev, G.I.; Pavlov, V.N.; Rafikov, R.S.; Shvetsova, L.E. No. 26, 16-18(1975). (In Russian).

2 refs.; 2 figs.

The ERI-1 electric-spark radioisotope injector can be used to have, in a specified place of a borehole, portions of fluid (oil, fresh water or a mixture of both) labelled with a solid metal gamma tracer. The tracer is readily carried along by the fluid and allows its movement to be followed. The injection of a tracer with an ERI-1 device into boreholes containing mineralized water is not envisaged. In this case the device should be used under condition of anodic dissolution. The feasibility of such an application has been investigated by the authors on the Ust'-Balyk oil field where stratal water with a salinity of about 20 g/1 is used for waterfloodig. The conclusion has been made that it would be possible to use the injector in radioisotope investigations in boreholes filled with mineralized water for following with certainty the movement of the tracer in the nonhermetic cement ring of a borehole shaft as well as for registering the emergence of the tracer in the water absoring layers.

PROCESSING

171 (PB—266827) Sorbent selection for the CAFB residual oil gasification demonstration plant. Final task report Apr 1975—Mar 1976. O'Neill, E.P.; Keairns, D.L.; Alvin, M.A. Mar 1977. Contract EPA-68-02-2142. 29p. NTIS PC A03/MF A01.

The report gives results of evaluations of limestones from Texas and Mexico as candidate sulfur sorbents for the chemically active fluid-bed (CAFB) gasification demonstration plant at San Benito, Texas. Preliminary laboratory tests show that three limestones quarried in Texas and one quarried in Mexico should be suitable sorbents, based on availability, chemical characterization, physical characterization, attrition behavior, and chemical reactivity as sulfur sorbents. Current sorbent selection criteria are being refined.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 1006, 1017, 1019

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 1020, 1396

172 (AD-A—041315) Development of a streaming-fiber oil spill control system, stage II. Final report 26 Sep 75—22 Nov 76. Beach, R.L.; Durfee, D.W.; Powers, R.J. Dec 1976. Contract DOT-CG-40217-A. 150p. NTIS PC A07/MF A01.

Seaward International, Inc. has developed the streaming fiber oil spill control concept into a large-scale model, and tested it successfully under simulated field conditions.

173 (ORNL/SUB—75/38283/2) Salt dissolution in oil and gas test holes in central Kansas. Part II. Salt dissolution in oil and gas test holes in the Gorham Oilfield, Russell County, central Kansas. Walters, R.F. Jun 1975. Contract W-7405-ENG-26. 109p. Dep. NTIS, PC A06/MF A01.

Within the Gorham Oilfield, there are two areas of surface subsidence caused by salt dissolution in three abandoned oil wells. Since these subsidence areas seriously affect Interstate Highway 70, they were carefully surveyed and studied. The Crawford Sink with over 20 feet of surface subsidence was investigated by the State Highway Commission by drilling a test hole between the abandoned twin oil wells. Their measurements prove that the subsidence is indeed due to salt dissolution, and is believed to be caused by former use of shallow brine disposal wells, the closest of which was only 1500 feet distant. All three abandoned oil wells penetrate two aquifers above the salt, which apparently still unload unsaturated brine down the old twin well bores dissolving the salt and causing the subsidence which is continuing at a diminishing rate. The 50-year old Gorham Oilfield is localized by a broad gentle anticline overlying a faulted Precambrian basement high. At the level of the oil producing Lansing-Kansas City limestone, near 3,000 feet, faulting is evident to the extent of 50 feet of the total relief of 100 feet. The 341 active oil wells, part under secondary recovery by waterflood, averaged 4.55 barrels of oil per day per well during 1974, but these "stripper wells" together accounted for an annual production of 565,991 barrels of oil in 1974. It is concluded that salt dissolution causing surface subsidence may continue even after abandonment of oil wells in the Gorham Oilfield. As the densely drilled aquifers slowly equalize pressures through the 1,600 poorly but legally plugged bore holes, unsaturated brine may continue to drain from the Cheyenne Sandstone and CedarHills aquifers downward by gravity across the salt section into the enormous Basal Sandstone and Arbuckle dolomite aquifer. (DLC)

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 1020

TRANSPORT, PIPELINES, AND HANDLING

174 Oil and gas fields and pipelines of Utah. Ritzma, H.R.; Burchell, P.W. Salt Lake City; Utah Geological and Mineral Survey (1976). 1p.

The Utah Geological and Mineral Survey presents a map, Oil and Gas Fields and Pipelines of Utah. The following statewide information is indicated: oil fields; gas fields; oil and gas fields; oil pipelines and gas pipelines with operator named and diameter; oil refineries, over 20,000 and less than 20,000 barrels per day capacity, with operator identified; natural gas processing plant with operator identified. Abandoned and shut in wells are indicated. Oil and gas producing formations in the state number mine are shown. (MCW)

PROPERTIES

REFER ALSO TO CITATION(S) 114

175 (AD-A—039655) The enthalpies of distillate fuels by a differential scanning calorimetric method. Research and development report. Zimmerman, J.G. May 1977. 34p. (DTNSRDC—77-0049). NTIS PC A03/MF A01.

The enthalpy differences and heat capacities of five Navy Distillate fuels, one Diesel Fuel Marine, and one JP-5 fuel were determined in the temperature range -15 to +25 C (5 to 77 F) with a differential scanning calorimeter. Enthalpy differences and heat capacities were determined to a standard deviation of about 4%. The differential scanning calorimeter method also provided a means of estimating wax contents and wax formation temperatures to + or - 2 degrees C. The method is proposed as a quick and reasonably accurate means of determing the enthalpy differences of fuels over the temperature region appropriate to low-temperature fuel handling. (Author)

176 (AD-A—039977) Development of high stability fuel, executive summary. Report for 15 Dec 1969—30 Nov 1976 . Taylor, W.F.; Frankenfeld, J.W. Feb 1977. Contract N00140-74-C-0618. 12p. (EXXON/GRU—18GAHF.77). NTIS PC A02/MF A01.

This report contains an Executive Summary of the work done on the Development of High Stability Fuel program which was carried out by the Government Research Laboratories of Exxon Research and Engineering Company for the Department of the Navy. The overall program consisted of an initial analytical study entitled, 'Investigation and Analysis of Advanced Hydrocarbon Fluids' followed by an extended experimental effort entitled 'Development of High Stability Fuel.' The Executive Summary discusses the following areas: (1) General Background, (2) Program Background, (3) Program objective and Approach, (4) Major Features of the Technology Which Was Developed, (5) Present Significance of This Technology, (6) Significance of This Technology for High Speed Aircraft, and (7) Significance in Relation to Future Synthetic Fuels. (Author)

177 Olefinic hydrocarbons from Bradford, Pennsylvania, crude oil. Hoering, T.C. **20**: No. 1, 1-8(Jul 1977).

A distillation fraction of 2 percent of a crude oil from the Bradford, Pennsylvania, field was isolated as olefinic hydrocarbons. The olefins are approximately 40 percent normal, 30 percent

branched chain, and 30 percent monocyclic. The double bonds are mainly in the trans configuration and are located in internal positions of long carbon chains. The carbon skeletons of the olefins and the coexisting saturated hydrocarbons correspond closely and have identical ^{13}C contents. The observed molecular structures can be accounted for by a process of natural thermal cracking of saturated hydrocarbons followed by a rapid disappearance of cis and terminal olefins.

STORAGE

REFER ALSO TO CITATION(S) 336

COMBUSTION

REFER ALSO TO CITATION(S) 214

178 (AD-A—041216) **EPA laser flame analyzer system. Final report 1 Jul 1973—8 Feb 1976.** Bentley, H.T. III; Bomar, B.W. Jun 1977. 57p. (AEDC-TR—76-150). NTIS PC A04/MF A01.

An electro-optical laser flame analyzer system specifically designed for EPA applications is described. Preliminary studies to establish design criteria included 1) studies of radiation levels at a number of discrete wavelengths corresponding to common laser wavelengths (that is, HeNe, argon ion, and ruby); 2) determination of fringe quality by means of an imaging system and an acoustically driven probe wire; 3) estimates of particle arrival rates for both oil and gas fired flames; and 4) effect of flame turbulence on LV signals. The EPS laser flame analyzer system consists of a specially adapted two-component laser velocimeter. Provisions were made to include, upon completion of development, both interferometric particle sizing and a third component of velocity.

179 (EPA—600/2-76-212, pp 373-389) **Assessment of the applicability of catalytic oxidation of hydrocarbon and other fuels for control of NO/sub x/ and other pollutants from area sources.** Kesselring, J.P. (Acurex Corp., Mountain View, CA); Martin, G.B.; Brown, R.A.; Moyer, C.B. Aug 1976.

From Symposium on environment and energy conservation; Denver, Colorado, USA (3 Nov 1975).

In Symposium on environment and energy conservation.

A review of the state-of-the-art of catalytic combustion concepts has been carried out, and an assessment of the applicability of catalytic combustion to gas- and oil-fired home heaters and commercial and industrial boilers has been made. Newly developed high-temperature support materials will greatly enhance the field of high-temperature catalytic combustion, but current catalyst systems are limited by the catalyst coating to much lower temperatures than the supports. In order to keep combustor temperatures below those that would cause catalyst degradation, as well as to achieve high system efficiency and also to prevent NO/sub x/ formation, combustion system concepts such as two-stage combustion, flue gas recirculation, and bed heat removal appear necessary. The application of these concepts to home furnaces appears feasible, but the application to larger-size units may be more attractive because of their larger initial cost, generally more sophisticated controls, better supervision of equipment, and heat transfer characteristics.

180 **Burning of water-in-oil emulsions.** Sjoegren, A. (Technological Inst., Copenhagen). pp 297-305 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

In a project entitled "Improved fuel oil combustion" several methods for reduction of the particulate (oil coke) emission resulting from the combustion of fuel oil were examined. By far the best method proved to be dispersion of water into the fuel oil. Four methods for carrying out this dispersion are described: (1) ultrasonic homogenizing, (2) mechanical (liquid whirling) homogenizing, (3), centrifugal pump as emulsifier and (4) atomization of water into the oil by means of pressure jet nozzles. Results are shown from trials with all four methods. It is claimed that the effect of the water is physical. When firing a water-in-oil emulsion, smaller oil droplets are produced by the sudden evaporation of the water droplets in the emulsion upon entering the combustion chamber. A sort of secondary atomization is thereby achieved. A 2-5 μm (microns) water droplet should be aimed at, as much larger droplets will not be incorporated in the oil drops and will thus be ineffective, and the rather large amount of water they represent will be wasted. If the dispersion of water in the oil is not very efficient, reductions in oil coke emissions of about 90% can be obtained with 10 to 15% water. If, however, the dispersion is very fine so that no water is wasted in the form of large droplets, 2 to 3% water is sufficient. Examinations of the collected oil coke particles in a scanning electron microscope confirm the theory that the water breaks up the oil droplets as the particles that measure 30 to 50 μm when fired without water are reduced to a size of 2 to 5 μm when fired with water. Moreover fragments of broken particles are found, which seems to indicate that some of the droplets do not break up until after coking of the surface has taken place.

181 **Combustion of water-in-oil emulsions and the influence of asphaltene content.** Jacques, M.T.; Jordan, J.B.; Williams, A.; Hadley-Coates, L. (Univ. of Leeds, Eng.). pp 307-319 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

An experimental investigation has been made of the combustion of single droplets of a heavy fuel oil and of water-in-oil emulsions by both photographic and gravimetric techniques. Both mass reduction rates and size variations have been followed for combustion in a furnace at temperatures of 1013 to 1173°K. The effect of adding up to 15% water in the form of an emulsion and of varying the asphaltene content of the base oil between 0.36 and 10% wt has been investigated. Emulsified oils exhibit massive swelling and disruption during the pre-ignition period not shown by the pure oil itself and also premature ignition can occur. Increasing the water content of the emulsion has very little effect on the rate constant Kp, due to the increased pre-ignition mass loss caused by massive disruption, indicating that the actual burning rate is decreased. However the formation of carbonaceous residues is greatly reduced due to the suppression of the liquid phase cracking reactions as a consequence of the preferential heat sink effect of the water drops. This heat sink effect is predicted by a simple mathematical model of the transient heat transfer, thermal cracking and water vaporization processes occuring within a single droplet. Results from this model show that under the conditions of the experimental studies, water addition in excess of 5% effectively prevents thermal cracking reactions from occurring during the droplet lifetime. Parallel measurements have been undertaken in a small residual fuel oil furnace. The effect of water emulsification on a range of oils with varying asphaltene content on total particulate emissions and size distribution has been studied. The results are discussed in terms of the single droplet model.

182 **Influence of droplet evaporation on fuel-air mixing rate in a burner.** Komiyama, K. (Komatsu Ltd., Tokyo); Flagan, R.C.; Heywood, J.B. pp 549-560 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

The importance of droplet evaporation in the overall fuel-air mixing process in liquid fuel spray flames is examined with a series of experiments in a simple atmospheric pressure burner burning a range of hydrocarbon fuels. Two types of fuel atomizers were studied--air-assist and pressure jet--which have substantially different operating characteristics. Fuel-air mixing rates were determined from time-average oxygen concentrations measured with overall burner operation stoichiometric. It is shown that with air-assist atomizers, the kinetic energy of the atomizer jet determines the mixing rate intensity for both liquid and gaseous fuels. Since the droplet evaporation time is much less than the mixing time, the details of the evaporation process are not important and the jet length scale and kinetic energy govern the mixing process. With pressure jet atomizers, the characteristic evaporation and mixing times are comparable. The evaporating fuel drops create fuel vapor concentration nonuniformities on a scale much smaller than the fuel jet scale. Mixing rate intensities comparable to those obtained with air-assist atomizers can, therefore, be achieved with much lower turbulent kinetic energy dissipation rates. With pressure jet atomizers, both the kinetic energy of the fuel jet and the evaporation characteristics of the fuel droplets control the initial fuel-air mixing rate.

183 **Further experiments on the structure of a spray combustion flame.** Onuma, Y.; Ogasawara, M.; Inoue, T. (Osaka Univ.). pp 561-567 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

In previous studies, the authors conducted experiments on spray combustion flames of axial jets of kerosene under comparatively low turbulence conditions. The results showed that droplets within the flames do not burn individually with envelope flames, but that a cloud of fuel vapor generated by them burns as a turbulent gas

diffusion flame, and that the spray combustion flame is very similar to the turbulent gas diffusion flame in structure. The present study is intended to examine the extent to which the above conclusions are valid, that is: (1) whether the similarity between the spray combustion flame and the turbulent gas diffusion flame also exists in nitric oxide formation; (2) whether the above conclusions can be applied to the flame of a low volatile heavy oil. In the radial distribution within the kerosene flame, the profile of NO concentration showed two peaks symmetrical with respect to the flame axis. These peaks coincide approximately with the peaks of the temperature profile, and with the points where the local equivalence ratio is unity. The above tendency is the same as in the turbulent gas diffusion flame and confirms that the spray combustion flame is also similar to the turbulent gas diffusion flame in the NO formation process. Next, a heavy oil flame was experimentally compared with a kerosene flame under the same condition. The result showed that the shape and the measured profiles of various quantities were almost the same for both flames. This shows that the heavy oil flame does not differ significantly in structure from the kerosene flame under the conditions of this experiment.

184 Aerodynamic and thermodynamic characteristics of kerosene-spray flames. Khalil, E.E.; Whitelaw, J.H. (Imperial Coll. of Science and Tech., London). pp 569-576 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

Measured values of velocity, turbulence intensity, temperature, temperature fluctuations and droplet concentration are reported in four kerosene spray flames burning vertically in atmospheric air. The results are compared with calculated values, obtained with the aid of a numerical solution of modelled conservation equations in differential form, and appropriate to a gaseous flame of the same available enthalpy. Velocity, turbulence intensity and droplet measurements were obtained with a laser anemometer operating in forward scatter: a frequency tracking demodulator provided the velocity information and the number of particles crossing the control volume at a given time were measured with the aid of a digital counter. Measured mean and fluctuating temperature were obtained with platinum-rhodium thermocouple wires of bead diameters 180 to 40 μm respectively. Corrections were made for conduction and radiation effects on the mean temperature and for the effect of the thermal inertia of the smaller wire on the rms measurements. The comparison between measurements and simulated gaseous flames, indicates that the flames have properties which are similar in general but significantly different in detail. The length of the flame decreases significantly from a spray of 100 μm to 50 μm droplets; and the simulated gaseous flame is still shorter and is not, therefore, a good approximation to spray flames. The measurements of rms velocity and temperature indicate values in excess of 0.75 and 0.30 respectively and the maxima appear to be coincident with the inflection points of the corresponding mean distributions.

185 Modelling of a high intensity spray combustion chamber. Munz, N.; Eisenklam, P. (Imperial Coll. of Science and Tech., London). pp 593-604 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

A combustion chamber is modelled in terms of a flow configuration of stirred and plug flow reactor elements, each corresponding functionally to a specific part of the physical chamber. The flow configuration is identified from experimental stimulus response results obtained under operating conditions. Spray combustion in each reactor element of the flow configuration is predicted using a model for the evaporation of a polysize spray followed by homogeneous pyrolysis and a 22 step kinetic reaction mechanism. The method was used to predict the trends in nitric oxide emission and formation in a 100 kW high intensity combustion chamber burning gas oil and the factors which determine these trends were identified. It can be concluded that for the chamber, a plug flow reactor element at the exit plays a very useful part in completing the reaction but need not drastically increase the level of NO emissions, provided NO formation is kept low in the initial part of the chamber. This can be achieved by providing a lean mixture there and keeping the temperature low even if combustion is fuel rich on an overall basis. It is noted that in practice, this principle is applied in two stage combustion systems. Further work linking physical design parameters with the desirable characteristics obtained in this work is necessary before such systems can be optimized.

186 Combustion of air blast atomized spray flames. Styles, A.C.; Chigier, N.A. (Univ. of Sheffield, Eng.). pp 619-630 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

Detailed experimental examination has been made of a series of air blast kerosene spray flames in secondary air flows in the wake of a stabilizer disc. Photography showed an initial dense spray region, with no combustion, surrounded by a gaseous diffusion flame. A laser diffraction technique was used for the measurement of droplet size distributions and their variation in the unignited spray. A laser anemometer with frequency shift, for reverse flow measurement, and a digital pulse counter was used for measurement of instantaneous velocity. Temperature was measured by miniature coated unshielded thermocouples and by suction pyrometer. Gas concentrations were measured in the flame by microprobes with analysis by gas phase chromatography. Droplet diameters decrease in the initial region of the spray due to secondary atomization, while further downstream, preferential vaporization of small droplets leads to increase in mean diameter of droplets. Increasing the air flow rate results in significant reduction in droplet diameter throughout the spray length. Velocities in spray flames are significantly higher than in nonburning sprays as a result of acceleration caused by increased volumetric flow rate due to phase change and temperature increase. Concentration measurements show lack of oxygen in the central core of the spray where carbon particles, carbon monoxide and hydrogen are formed.

187 Stabilization of spray flames in a high-temperature stream. Mizutani, Y.; Yasuma, G.; Katsuki, M. (Osaka Univ.). pp 631-638 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

The structure of the flame front and the mechanism of flame stabilization were studied for spray flames stabilized in a high-temperature stream. The flux of the fuel droplets and the composition of the interdroplet gas were measured in flames using a specially designed sampling probe and analyzing system. The rate of entrainment of the surrounding stream into a spray was determined by the flow visualization technique. The hydrocarbon gas produced by evaporation of the droplets around the spray boundary plays a major role in the process of flame stabilization. Therefore, the convective heat flux entrained through the spray boundary is a principal parameter governing the location of the flame front. Spray flames are stabilized in a high-temperature stream principally by the flame propagation mechanism. The flame front, therefore, approaches the injection nozzle far more closely than would be expected from the ignition delay data.

188 Ignition delays of spray columns behind a reflected shock. Miyasaka, K.; Mizutani, Y. (Osaka Univ.). pp 639-645 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

An experimental investigation of the ignition of a premixed spray column behind a reflected shock was carried out to obtain ignition delay data free from atomizing and mixing processes. The influences of pressure, concentration of oxygen, fuel composition and droplet size on the ignition characteristics were examined. Ignition delay of a cetane spray, t/sub re/ ms, can be correlated with the temperature, T_sK, the partial pressure of oxygen, p/sub O_2/ N/m^2, and that of nitrogen, p/sub N_2/, behind a reflected shock as follows: t/sub re/ = 0.504 p/sub O_2/ /sup -0.378/ p/sub N_2//sup 0.266/ exp (2,150/T_s). The major result obtained in this study is that the ignition delay of a premixed spray column is dominated by the increasing rate of local temperature at the ignition point, which depends both on the heat released by chemical reactions and the heat loss to the surroundings. The data were also compared with those of the spray injected from a hole nozzle into an electric furnace.

NATURAL GAS

REFER ALSO TO CITATION(S) 953

GEOLOGY AND EXPLORATION

REFER ALSO TO CITATION(S) 114, 119, 120, 121, 122, 124

189 (CONF-770836—P2, pp E.1.1-E.1.15) **Geological program to provide a characterization of tight, gas bearing reservoirs in the Rocky Mountain region.** Spencer, C.W.; Fouch, T.D.; Rice, D.D. (U.S. Geological Survey, Denver). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

The U.S. Geological Survey is now studying the areas and rock units that have the best resource potential in the region. These are the tight sandstone and siltstone reservoirs of early Tertiary and Late Cretaceous age in the Uinta, Piceance, and Greater Green River Basins, and Upper Cretaceous sandstone, siltstone, shale, and marl reservoirs in the northern Great Plains. The purpose of the present investigation is to outline the distribution of low-permeability gas-bearing formations, characterize the reservoirs, assist in improving the recovery technology, and provide a refined estimate of in-place gas resources. The amount of recoverable gas is dependent on economic factors and advancements in recovery technology. A wide variety of geological techniques is being used to resolve resource and recovery technology problems in tight gas sands.

190 (CONF-770836—P2, pp G.3.1-G.3.7) **Internal surface area and porosity in eastern gas shales from the sorption of nitrogen, carbon dioxide, and methane: a status report.** Thomas, J. Jr.; Frost, R.R. (Illinois State Geological Survey, Urbana, IL). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

The adsorption of N_2 at -196°C and of CO_2 at -77°C on Eastern gas shales reveals significant differences in their micropore structures. Owing to differences in the activated diffusion of the two gases at their respective adsorption temperatures, as studies on molecular sieves and coals have shown, CO_2 is able to penetrate pores less than 4 to 5 A in diameter, whereas N_2 is unable to do so. One measure of this difference is in the internal surface area (ISA) estimated from the BET method. For example, shale samples from a Kentucky core, with CO_2 as the adsorbate, have ISA values ranging from 10 to 39 m^2/g, whereas the ISA values from N_2 adsorption on the same samples range from 0.8 to 8.7 m^2/g. The diffusion rate of a gas initially contained within such an ultramicroporous network will be greatly decreased in comparison with the diffusion rate from shales containing larger pores. High-pressure (up to 80 atmospheres) methane adsorption isotherms near room temperature are shown for selected shale samples. These isotherms provide supplemental information with regard to total porosity and the gas-holding capacity of shales at depth of burial.

191 (CONF-770836—P2, pp G.4.1-G.4.9) **Characterization and analysis of Devonian shales as related to release of gaseous hydrocarbons.** Snyder, M.J.; Kalyoncu, R.S.; Coutant, R.W.; Rausch, M.P.; Ogden, J.S.; Hooie, D.T. (Battelle Columbus Labs., Columbus, OH). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

As part of the Resource Inventory and Shale Characterization subprojects of ERDA's Eastern Gas Shales Project, Battelle's Columbus Laboratories is conducting a program to determine the relationships between shale characteristics, hydrocarbon gas content, and well location. Ultimately about 1000 core samples of gas bearing Devonian shales will be selected and sealed in special containers to preserve their approximate "down-hole" condition, and the gas-release characteristics and various chemical, physical and lithologic characteristics will be determined. Partial data have now been collected on about 150 samples from 8 different wells in both the Appalachian and Illinois basins. Initial findings and possible implications of them are discussed.

192 (CONF-770836—P2, pp G.5.1-G.5.9) **Characterization of the Devonian shales in the Appalachian and Illinois Basins.** Zielinski, R.E. (Mound Lab., Miamisburg, OH). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

The characterization of the nature of the Devonian Shales in the Appalachian Basin is being addressed by several geochemical and geophysical methods. The outgassing characteristics of the shale are being investigated using gas chromatography and mass spectrometry. An extensive geochemical characterization of the samples is also being performed. Mechanical testing and mass spectrometry have been integrated to provide some insight into the mechanical properties of the shale and gas released from the shale as a function of newly exposed surface area. Mechanical tests are also being performed in an attempt to determine the effects of moisture on the mechanical properties of the shale. Dilatometry is being used to study the swelling characteristics of the shale samples as a function of exposure to water and other fracturing fluids. Several other methods of investigation also are serving to characterize the Devonian Shales and their fuel resources.

193 (CONF-770836—P2, pp G.11.1-G.11.9) **New Albany Shale and correlative strata in Indiana.** Bassett, J.L.; Hasenmueller, N.R. (Indiana Geological Survey, Bloomington). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

The New Albany Shale has a maximum thickness of 337 feet in southwestern Indiana and thins northward and eastward to about 90 feet in the outcrop area. In the Michigan Basin, strata equivalent to the New Albany are 348 feet thick in Lagrange County. The base of the New Albany is 4,500 feet below sea level in southwestern Indiana, and the base of the Antrim Shale is 150 feet above sea level in northern Indiana (Lagrange County). In the Illinois Basin the New Albany is divided into four members: the Hannibal, Grassy Creek, Sweetland Creek, and Blocher Shales. The lithologic equivalents of the New Albany in the Michigan Basin are the Sunbury, Ellsworth, and Antrim Shales. The New Albany produced commercial gas from seven fields in Harrison County and one field in Martin County. Two small gas fields have been found in the New Albany in Daviess County.

194 (CONF-770836—P2, pp G.12.1-G.12.7) **Characterization of the Devonian shales and evaluation of their energy-producing potential: some approaches and preliminary results.** Erwin, R.B.; Woodfork, L.D.; Patchen, D.G. (West Virginia Geological and Economic Survey, Morgantown, WV). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

On July 1, 1976 the West Virginia Geological and Economic Survey initiated an intensive 5-year study of the Devonian shales in West Virginia under a contract from the U.S. Energy Research and Development Administration. The objective of the project is to characterize adequately the shales and to determine accurately their total energy-producing potential including natural gas and oil, synthetic fuels, and radioactive minerals. The approach used is a detailed and integrated study of the stratigraphy, petrology, and geochemistry of the shales with the data synthesis and analysis accomplished with the assistance of the computer. The work to date is reported.

195 (CONF-770836—P2, pp G.16.1-G.16.13) **Thermal maturity and organic facies of Devonian shales from selected wells.** Zielinski, R.E. (Mound Lab., Miamisburg, OH); Martin, L.J. 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

An organic geochemical study was performed on core samples of the Devonian shale from wells in Ohio, Kentucky, and Illinois. The thermal maturity of the organic matter (kerogen) contained in the fine-grained sediments was investigated by vitrinite reflectance and kerogen coloration (Thermal Alteration Index). The results indicate that the organic matter has been thermally matured to the early stages of petroleum and associated gas generation. A suite of geochemical analyses designed to evaluate the organic richness, the hydrocarbon potential for gas, condensate, and/or oil, and the type of organic matter was performed on the samples analyzed for thermal maturity. In general, two types of organic facies were encountered. The rich organic facies (A) are characterized by abundant gas, gasoline, and gas-oil hydrocarbons, a high organic carbon content, and organic matter prone to generate abundant oil and associated gas. Based on the geochemical data, a second type of organic facies (B) interbedded with the rich organic facies (A) was encountered in Kentucky and Ohio wells. Organic facies B consist of sediments relatively lean in organic carbon and gas-oil hydrocarbons, and abundant gas and gasoline hydrocarbons. In most cases, facies B are composed of woody and coaly types of kerogen. The woody-coaly kerogen is presumed to indicate a nonmarine derived depositional source prone to generate predominately gas (methane).

196 **Alluvial minerals: an important source of information in evaluating anomalies.** Kosterin, A.V. (Far Eastern Geological Inst., Vladivostok, USSR). No. 10, 128-132(Oct 1976). (In Russian).

Evaluation of geochemical anomalies rests upon spectral analysis of alluvial deposits. An additional, important source of information on the mother lode can be obtained by studying minerals found in alluvial sands within the boundaries of the anomalies. The minerals can be investigated by various methods. A determination is made of the kinds and amounts of element impurities, the character and features of gas-liquid inclusions, the physical properties (thermo-emf,

electrical conductivity, hardness), the isotopic composition, the purely external typomorphic features, etc. Thus it is possible to obtain a large amount of information about mother lodes from alluvial minerals by investigating only a few individual mineral grains found in alluvial sands. The evaluation of anomalies in this fashion is just as reliable as though the mineral were selected from the original ore. Thus it is possible to evaluate anomalies tens and hundreds of kilometers from the original source. 21 refs. (SJR)

197 Relation of a number of gaseous components with mercury ore formation within the boundaries of the Nikitovskii orc field. Makhlova, N.K. No. 9, 133-137(Sep 1976). (In Russian).

Data are given on the composition of natural gases in intrusive and hydrothermally changed ores with mercury mineralization, genesis of the gases, and distribution areally and depthwise within the boundaries of separate sites in the Nikitovskii ore field. From an analysis of the composition and contents of natural gases in the hydrothermally altered ores it was possible to show the spatial and genetic relation of carbon dioxide gas and hydrogen with mercury. The zonal distribution of these gaseous components reflects the zonal develoment of mineralization and ore deposition processes. The kind of natural gas distribution can serve as an additional search criterion for finding minerals. (SJR)

198 Peculiar lithological structure features of a productive horizon of the Shatlyk gas deposit. Gergedava, Sh.K.; Sokolova, T.F.; Friman, Yu.T. No. 22, p. 23-27(1975). (In Russian).

1 fig.

Investigation results on the lithologic heterogeneity of the productive horizon in the Shatlyk gas field are cited. The work was performed by a set of commercial and geophysical procedures involving the method of spontaneous polarization potentials, side electrical sounding with five probes, cavernometry, microsounding, side logging and radiometry (neutron gamma method and gamma method). The structural peculiarity of the Shatlyk horizon was shown to possibly lead to non-uniform movement of seam waters during drilling and to flooding of wells.

DRILLING, PRODUCTION, AND PROCESSING

REFER ALSO TO CITATION(S) 1267, 1268, 1269

199 (CONF-770836—P2, pp G.10.1-G.10.12) **Relationship of thermodynamic and kinetic parameters to well production in Devonian shale.** Schettler, P.D. Jr.; Wampler, D.L.; Sipling, P.J.; Mitchell, D.J. (Juniata Coll., Huntingdon, PA). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

A mathematical model describing production of gas from wells in Devonian shales is introduced, and the extent of agreement with existing productivity data is discussed. Parameters needed for this model include the diffusion constant of gas through the rock and the sorption isotherms of gas within the rock. Methods and results of measurements of these important parameters made in our laboratories are described and discussed.

200 (CONF-770836—P2, pp G.13.1-G.13.5) **Analysis of structural geological parameters that influence gas production from the Devonian shale of the Appalachian Basin.** (West Virginia Univ., Morgantown, WV). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

The Department of Geology and Geography at West Virginia University is studying the structural parameters that may affect gas production from the Devonian shale in southwestern West Virginia and eastern Kentucky. The project is designed to (1) document fracture patterns and structural deformation within and around areas of Devonian shale production; (2) evaluate inexpensive geophysical and remote sensing techniques to locate potentially productive fracture zones; and (3) study production within producing fields for comparison with adjacent non-productive areas to assess the influence of structure on production. Work was initiated this year on regional analysis of basin structures, compilation of surface fractures from eastern Kentucky and West Virginia, shallow high frequency seismic and resistivity studies to locate fracture zones and groundwater studies above the Cottageville Devonian shale gas field for comparison with a production study of that same field.

201 (CONF-770836—P2, pp G.14.1-G.14.7) **Remote sensing methods for application to natural gas production from fractured Devonian shale reservoirs of western West Virginia.** Werner, E. (West Virginia Univ., Morgantown). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

Natural gas production from the Devonian black shales of the Appalachian Basin is from fracture permeability. The possibility that wells drilled on zones of increased fracturing may be better producers coupled with the fact that some fracture zones are visible on remote sensing imagery as photolineaments initiated this project. Photolineaments were mapped from various types of imagery, and natural gas initial production data were obtained from driller's logs. The relation between initial production data and proximity to various types of photolineaments for the gas wells indicates that such relationships are very complex.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 1006, 1021

ARTIFICIAL STIMULATION, PLOWSHARE, ETC.

REFER ALSO TO CITATION(S) 127, 128, 165

202 (CONF-770836—P2, pp H.4.1-H.4.11) **Rock mechanics aspects of MHF design in eastern Devonian shale gas reservoirs.** Jones, A.H.; Abou-Sayed, A.S.; Rogers, L.A. (Terra Tek, Inc., Salt Lake City). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

As part of an ERDA/OGST program, rock mechanics considerations are used to help design a deeply penetrationg hydraulic fracture in Devonian shale at a Columbia Gas System Service Corporation well in Lincoln County, West Virginia. Rock properties of the pay zones were considered in relation to the barrier formations. Formation properties—specifically, elastic moduli critical stress-intensity factor and the minimum in situ stress—were determined from laboratory core measurements and field tests. Analyses using the formation properties above suggest that the Middle Brown shale zone is the layer (in the Devonian shale) that is most likely to "contain" a hydraulic fracture. That is, a fracture containment analysis indicated that the Gray shales on either side of the Middle Brown shale would act as barriers to fracture growth, provided the fracture fluid is injected at a pressure that does not exceed a naturally occurring stress in the reservoir rock by more than about 400 psi. Fractures initiated in the Gray shales would be expected to move out of zone.

203 (CONF-770836—P2, pp E.3.1-E.3.11) **Demonstration of massive hydraulic fracturing mesaverde formation, Piceance Basin, Colorado.** Fitch, J.L. (Mobil Research and Development Corp., Dallas). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

Demonstration of the efficiency and economics of massive hydraulic fracturing (MHF) in low permeability gas reservoirs is the objective of this project. It is being conducted by Mobil Research and Development Corporation with support from the United States Energy Research and Development Administration. The test site is the Piceance Basin in western Colorado. The Mesaverde Formation in this basin is more than 2500 feet thick and contains numerous gas bearing sands. Mobil has conducted one MHF test in the Basin which failed to achieve commercial production because of extremely low reservoir permeability. The current test is in the Piceance Creek Federal Unit, Section 13, T2S, R97W, Rio Blanco County, Colorado. The well has been drilled, logged, and cased to 10,800 feet. Cores were taken at 8840 to 8500 and 9940 to 10,000 feet. Standard core analysis gives porosity of the sands less than 10 percent and specific permeability less than 0.1 md. Logs of the Mesaverde Formation in the test well are similar in character to those obtained in the nearby well No. 54-13. The lowest interval containing sands suspected to be of reservoir quality has been perforated from 10,549 to 10,680 feet. Gas inflow rate after perforating was estimated at 250 MCF per day, declining to about 100 MCF per day after flowing for about two days. If additional testing shows the interval to be suitable for MHF, it will be fractured with about 600,000 lb of sand carried by a cellulose gel. Additional intervals will be tested for suitability for MHF and up to six fracturing treatments performed. Completion of the project is scheduled for late 1978.

204 (CONF-770836—P2, pp E.4.1-E.4.7) **Rulison Field massive hydraulic fracturing experiment.** Reynolds, M. Jr. (Austral Oil Co. Inc., Houston, TX). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

The Rulison Field, Garfield County, Colorado, has seven producing gas wells completed in the Mesaverde formation. One of these wells, the Federal No. 3-94, was selected for a massive hydraulic fracturing experiment. The Federal No. 3-94 has a producing history of more than ten years. The experimental fracture treatment was applied in two stages treating separately the gross perforated intervals from 6198 to 6363 ft (Stage 1) and 5170 to 5630 ft (Stage 2). Approximately 485,000 gal of gelled water, 1,070,000 lb of sand and 500 scf of nitrogen per barrel were used. A brief cleanup flow period was allowed between stages. The fracture treatments were performed in August 1976. The treatment was designed to extend a fracture approximately 1400 ft from the wellbore with a propped fracture width of 0.176 in. The production increase was expected to range from 5.5 to 6.2 times the pre-treatment rate of 35,000 scfd. The results of the massive hydraulic fracturing treatment were poor. Production of gas was enchanced by a factor of less than 2. The average flow rate during early 1977 was about 50,000 cfd. The lack of success is attributed to both low reservoir permeability and a restricted reservoir due to sand lenticularity.

205 (CONF-770836—P2, pp E.5.1-E.5.5) **Pacific Transmission Supply Company Sand Ridge Mesaverde Massive Hydraulic Fracture Project, Uintah County, Utah.** Beardsley, D.E. (Pacific Transmission Supply Co., Casper, WY); Allen, B.W.; Wroble, J.L. 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

Pacific Transmission Supply Company and the Energy Research and Development Administration contracted to evaluate approximately 2500 ft of Mesaverde formation in the Uinta Basin of northeastern Utah. The contract proposal called for continuous drillstem testing of the Mesaverde, coring of 400 to 500 ft of the formation to determine rock characteristics, continuous mud logging, and open-hole logs, including a Schlumberger Experimental Acoustic log to attempt to determine rock mechanical properties. Further, special core work was to be done to determine in-situ stress field and in-situ permeability and porosity insofar as possible. Mini-fracturing of selected intervals were then to be performed in the open-hole before running casing to help determine in-situ rock stress fields. Impression packers were to be run after mini-fracturing to determine fracture direction. Analyses of data obtained during drilling were to be made to help in design of three massive hydraulic fractures in sandstones of the basal, middle and upper Mesaverde. The fractures would only be performed if gas producing sandstones could be shown to aggregate a gas transmissibility of 0.5 millidarcy-feet in the lower Mesaverde and 1.0 millidarcy-feet in each of the middle and upper Mesaverde. The test well was drilled and reached a total depth of 9282 feet on January 21, 1977. Production casing was run, and subsequently eight sandstone zones were perforated to test for feasibility of gas production. These eight zones were selected from critical analyses of drillstem tests, gas log and open-hole logs, although all zones showed gas production in small amounts.

206 (CONF-770836—P2, pp E.6.1-E.6.13) **Review of Natural Buttes Unit Massive Hydraulic Fracturing Project.** Short, J.A. (Gas Producing Enterprises, Inc., Denver). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

A Massive Hydraulic Massive Fracturing program has been initiated in the Natural Buttes Unit, a marginal gas field located in the Bitter Creek Field in the Uinta Basin of northeastern Utah. The program includes fracturing nine wells (new and old) with different combinations of types and volumes of fluid, size and amount of sand and methods of placement to find the completion procedure which is most effective in recovering gas from these low permeability sands. Fracture orientation tests will also be conducted. There is a pending program modification to allow for coring, extensive electric logging, pre-frac testing, etc., on one well. Four wells have been fractured to date under this program.

207 (CONF-770836—P2, pp E.7.1-E.7.15) **Massive hydraulic fracturing experiment No. 1, Home Federal Well, Uintah County, Utah.** Boardman, C.R. (Western Oil Shale Corp., Las Vegas, NV). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

Two massive hydraulic fracturing experiments were performed on two separate gas-bearing intervals of Mesaverde sandstones in the No. 1 Home Federal well located in Uintah County, Utah. KCl water was used as the frac fluid and the limited entry technique was used for injection. The first experiment was carried out on an interval containing 112 ft of net pay at a depth of 10,014 to 10,202. Pre-frac production capacity was estimated to be 60+ MCF/D. Post-frac production capacity was significantly less, presumably attributable to a limited lateral extent of inherent formation permeability. The second experiment was carried out on an interval containing 85 ft of net pay at a depth of 7,826 to 9,437 ft. Pre-frac production capacity of 33 MCF/D was increased by MHF to an initial 500 MCF/D and to a relatively stabilized 155 MCF/D within four months following the treatment.

208 (CONF-770836—P2, pp E.8.1-E.8.14) **Mesaverde hydraulic fracture stimulation, northern Piceance Basin: progress report.** Chancellor, R.E. (Rio Blanco Natural Gas Co., Denver). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

Information gained from massive stimulation projects in the northern Piceance basin was used to design a massive hydraulic fracture for a 130-ft-thick Mesaverde Group interval in a nearby well. Pre-frac log interpretations indicated individual sandstone units in the zone to be gas productive with variable reservoir characteristics. It flowed 55 Mcfpd after a pre-frac breakdown of 16 perforations. Seven thousand barrels of jelled KCl water and 775,000 lb of sand were successfully injected at the rate of 37 barrels per minute. With 70 percent fluid recovery after 12 post-frac days, the flow rate was 800 Mcfpd. After one month, it dropped to 200 Mcfpd and stabilized at 130 Mcfpd plus an average of 3 barrels of high gravity oil and 3 barrels of water after four months on $\frac{1}{4}$ in. coke at 60 lb tubing pressure. These results are similar to two previous KCl based fracs performed in the well. The KCl approach to drilling and completing Mesaverde wells in this area appears to offer economically successful stimulation ratios.

209 (CONF-770836—P2, pp F.3.1-F.3.20) **Update on the LLL gas stimulation program.** Hanson, M.E.; Shaffer, R.J.; Hearst, J.R.; Anderson, G.D.; Montan, D.N.; Heard, H.C.; Emerson, D. (Univ. of California, Livermore). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

The progress and current state of the Lawrence Livermore Laboratory research program on the stimulation of tight gas reservoirs are discussed. This is primarily a theoretical and laboratory program; however, the application and interpretation of geophysical logging is an essential part of it. The theoretical hydraulic fracturing models in their current state of development show that as the pore pressure is increased, the matrix stress around a fracture becomes more tensile. Laboratory experiments, which use unconfined specimens, show that both the characteristics of a layer and the mechanical properties of the adjacent materials control the fracturing in the region of the layer. We have acquired and interpreted some long-period seismic logging data. The preliminary analysis indicates gas-producing fractures intersecting the wellbore. Other fractures, which are either barren or do not intersect the wellbore, are also indicated by the data. Mechanical measurements of the Devonian shale indicate fairly uniform mechanical characteristics; however, a degree of mechanical anisotropy was noted for sections oriented horizontally or vertically with respect to the shale structure. Reservoir analyses of the Rio Blanco nuclear stimulation experiment and the nearby MHF experiment indicate that characteristic lens dimensions were 40 to 60 ft (12 to 18 m) vertically and 400 to 600 ft (120 to 180 m) horizontally.

210 (CONF-770836—P2, pp G.6.1-G.6.12) **Investigation of stimulation technology on tight gas reservoirs of the eastern United States.** McKetta, S.F. (Columbia Gas System Service Corp., Columbus, OH). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

A joint Columbia Gas-USERDA project, aimed at testing stimulation technology in various Appalachian Basin sandstones and shales, is currently being conducted. Its purpose is to ascertain whether massive hydraulic fracturing (MHF), dendritic fracturing (Kiel), or cryogenic fracturing techniques would substantially increase gas production in the reservoirs treated. This hydraulic fracturing program involves 13 wells and 14 fracturing treatments in five different producing reservoirs in several Appalachian states. The scope of the project includes the investigation of four dendritic fracturing treatments, four cryogenic treatments (in the Shales only) and six MHF treatments. Since the onset of this project, three MHF

treatments and one dendritic fracturing treatment have been performed. Two of these MHF treatments and the dendritic fracturing treatment were performed in the Clinton sandstone in northeastern Ohio. The third MHF treatment performed was in the Berea sandstone in western Virginia. When this project is concluded, the results of these tests can be used for a comparative assessment of the effectiveness of the various treatments conducted.

211 (CONF-770836—P2, pp G.7.1-G.7.14) **Massive hydraulic fracturing on the Devonian shale in Lincoln County, West Virginia.** McKetta, S.F. (Columbia Gas System Service Corp., Columbus, OH). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

Columbia Gas, in conjunction with the U. S. Energy Research and Development Administration (USERDA), is currently investigating the technical and economic effectiveness of massive hydraulic fracturing (MHF) techniques for enhanced gas recovery in the Upper Devonian shales of the Eastern United States. The project area includes three wells in a 5,000 acre undeveloped tract in western Lincoln County, West Virginia, approximately 40 miles southwest of Charleston, West Virginia. In each of these three wells, selected with remote sensing imagery for proximity to surface fractures (lineaments), the total depth encompasses the entire Upper Devonian Shale; a sequence which contains four primary zones of interest. The scope of this joint Columbia Gas-USERDA investigation is to individually stimulate these twelve zones of interest with various MHF techniques. Since inception, five MHF stimulation treatments have been performed using foam and modified water in two of the wells. The third well is being reserved to utilize information learned from the first two. Once complete, these ongoing tests can be used to assess the promise of large hydraulic fracturing treatments in stimulating these shales and designing future treatments.

212 (CONF-770836—P2, pp G.9.1-G.9.10) **AMEX/VESCORP Devonian Shale Project, Lawrence and Scioto Counties, Ohio.** Cochrane, J.N. (American Exploration Co., Worthington, OH); Ryan, F.D.; Alkire, S.H. 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

Amex/Vescorp in conjunction with U.S.E.R.D.A., Ohio E.R.D .A., and National Petroleum Corp., is conducting a field demonstration test to provide information on the Devonian shales, in Lawrence and Scioto Counties, Ohio, which can be used in the immediate and surrounding areas to increase gas production from the shale. The general objectives of this program are to establish the effectiveness of remote sensing imagery as a tool in picking shale well site locations, to determine the benefit of advanced stimulation techniques, and to determine if a scaled up version of the fracture technique deemed to be the better of the two above would be a cost-effective method of improving production rates and reserves. Analysis of the remote sensing imagery was completed on May 24, 1977. Nine primary and twelve alternate well locations have been selected as a result of this work. The drilling of these wells will commence in the near future at which time coring and logging will be used to help determine which zones should be stimulated.

TRANSPORT, PIPELINES, AND HANDLING

REFER ALSO TO CITATION(S) 174

213 (NTIS/PS—77/0603) **Natural gas: marine transportation (a bibliography with abstracts). Report for 1964-May 77.** Lehmann, E.J. Jul 1977. 83p. NTIS PC N01/MF N01.

Abstracts are presented of studies on all aspects of marine transportation of liquefied natural gas. This includes reports on forecasts, cargo tank design, terminal facilities, spills, safety aspects, special tanker design, and handling equipment. (This updated bibliography contains 78 abstracts, 23 of which are new entries to the previous edition.)

PROPERTIES

REFER ALSO TO CITATION(S) 114, 190, 191

COMBUSTION

REFER ALSO TO CITATION(S) 178, 179

214 **Experimental investigation of noise generated by large turbulent diffusion flames.** Bertrand, C.; Michelfelder, S. (International Flame Research Foundation, Ijmuiden, Netherlands). pp 1757-1769 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

The sound power of combustion noise emitted by a natural gas fired experimental burner (1 to 3 MW) was measured under free-field conditions and compared with the noise emitted inside a refractory furnace. Measurements under free-field conditions show that the noise power output is proportional to the average gas velocity to the 2.8 power and to the burner throat diameter to the 5.6 power. The peak frequency of the combustion noise ranges between 125 Hz and 300 Hz depending on the swirl number but not on the firing rate. Measurements inside the furnace show the predominance of resonance phenomena at low frequencies. The actual combustion noise could be evaluated by the sound pressure level measured in the 250 Hz or 500 Hz octave band. The increase of combustion noise with firing rate is greater than under free-field conditions, which can be attributed to an increase of the flame turbulence rather than to an increase of the gas temperature. Preheating the combustion air greatly increases the sound power output as well as the peak frequency. A study of noise emitted by three industrial burners inside the furnace confirmed these results, notwithstanding the very different flame shapes obtained. Oil flames were found to be less noisy than natural gas flames when the combustion air was not preheated, whereas this difference disappeared on preheating the combustion air or using a pregasification burner.

OIL SHALES AND TAR SANDS

215 (NP—22241) **Production of oil from Intermountain West tar sands deposits.** Glassett, J.M.; Glassett, J.A. Mar 1976. 91p. Research Institute, Provo, UT.

Six tar sand deposits in the Intermountain West, each containing more than one billion barrels of oil in place, are identified. All of these deposits are in eastern Utah and contain a total of twenty-eight billion barrels of oil. The names of the six deposits arranged in descending order of desirability for large-scale surface-mining oil recovery operations are as follows: Sunnyside, Tar Sand Triangle, Asphalt Ridge, P.R. Spring, Circle Cliffs, and Hill Creek. An overview of each deposit is presented including geology, surface-mining variables, chemical processing variables, environmental aspects, and economics. A comparison of Utah tar sands and Athabasca, Alberta, Canada tar sands is also presented.

SITE GEOLOGY

REFER ALSO TO CITATION(S) 190, 191, 192, 193, 194, 200

DRILLING, FRACTURING, AND MINING

216 (PB—266762) **GDIST: a computer code for analysis of statistical distributions of physical data. Information circular 1977.** Alldredge, J.R.; Bolstad, D.D. 1977. 63p. (BM-IC—8731). NTIS PC A04/MF A01.

This report presents a computer code that has been developed for describing and testing the statistical distribution of general continuous data sets. The statistical distributions used include the normal, lognormal, exponential, chi square, gamma, and uniform. Histograms for observed and expected values are plotted for each distribution. An example using geologic data obtained from a study of the geometric properties of natural fractures in oil shale rock illustrates the use of the computer program, GDIST.

PROPERTIES AND COMPOSITION

REFER ALSO TO CITATION(S) 113, 1236

217 (UCRL—52256(Pt.3)) **Oil shale retorting: Part 3, a correlation of shale oil 1-alkene/n-alkane ratios with yield.** Coburn, T.T.; Bozak, R.E.; Clarkson, J.E.; Campbell, J.H. 1 Aug 1977. Contract W-7405-ENG-48. 18p. Dep. NTIS, PC A02/MF A01.

Shale oil obtained by pyrolyzing oil shale in an autogeneous or inert gas environment was analyzed by high-resolution gas chromatography. It was found that ratios of l-alkenes to n-alkanes in the liquid oil correlate linearly with the percent of oil yield.

218 (TT—70-53097) **Chemistry and technology of shale tar.** Zelenin, N.I.; Fainberg, V.S.; Chernysheva, K.B. 1976. Translation of Izdatel'stvo "Khimiya", Leningradskoe Otdelenie, Leningrad, 1968. 437p. NTIS.

Results of prolonged investigations in the field of shale-processing and shale-chemical industry are classified and generalized for the first time in this book. The properties of oil shales, and the methods of manufacturi$g tar in generators, compartment kilns, tunnel ovens and various other units are mentioned. Problems related to the chemistry of shale tars--classification, methods of investigation, chemical composition, thermal transformation of tar and its basic components--are described. Considerable importance has been given to the questions related to the industrial processing of shale tar.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 1541, 1542, 1543

ENVIROMENTAL ASPECTS

REFER ALSO TO CITATION(S) 970

FISSION FUELS

REFER ALSO TO CITATION(S) 608

RESERVES

REFER ALSO TO CITATION(S) 298

219 **Fissiogenic nuclides in uranium minerals. 1. Mathematical treatment.** Garzon Ruiperez, L. (Oviedo Univ. (Spain). Escuela Tecnica Superior Ingenieros de Minas). **72**: No. 3, 200-203(Jul 1976). (In Spanish).

4 refs.

Starting from a deposit model of uranium constituted by a UO_2 uniformly dispersed into a standard matrix, the ratios Nsub(E)/Nsub(U) between the stable nuclides fissiogenic concentrations (produced by the natural uranium fissions) and those of the uranium, have been calculated. Such ratios, as a function of certain parameters, have been studied.

220 **Some statistical regularities in uranium distribution in the hydrothermal deposits.** Zontov, N.S. No. 6, 57-64(Jun 1976). (In Russian).

For selective English translation see the journal Int. Geol. Rev.

Statistical size distribution of lodes are considered and lode types containing the bulk of reserves are determined. The number of lodes is inversely related to the lode size. The relationship is illustrated by distribution curves for stockwork and veined lodes. The size of stockwork lodes at the exploration stage may be inferred from the size of ore intersection in the wells. Estimation of mineralization scale at this stage is based upon the regularities of mineralization and lode dislocation at the deposit as a whole. Lode dislocation within hydrothermal uranium deposits, area, length and depth are governed by geostructural and lithologic-stratigraphic factors. The curve of vertical distribution of commercial mineralization area is monomodal and symmetric for uranium deposits. Three zones are distinguished corresponding to the increase of mineralization with depth, the mineralization maximum, and the decrease and dissapearance of mineralization. This pattern has been observed for many uranium deposits irrespective of the geological conditions and lode morphology and, therefore, can be considered general and applicable to predicting the mineralization scale and depth. These statistical characteristics should be combined with conventional ones and may be useful in deposit exploration and evaluation.

221 **Stages of ore formation and the classification of exogenetic uranium deposits.** Danchev, V.I.; Strelyanov, N.P. No. 3, 11-24(May 1976). (In Russian).

The generally accepted division of exogenic uranium deposits into syngenetic and epigenetic does not reflect the variety of formation conditions of these deposits. A new genetic classification of uranium deposits in sedimentary rocks is proposed, based on the principle of conjugation of ore-formation process with lithogenesis stages of enclosing rocks. The stages of the ore-formation process corresponding to stages of formation and changing of ore-enclosing rocks together with the nature of uranium source are taken as principal, most general classification features of uranium deposits. Accordingly, the exogenic deposits are divided into the following classes: sedimentogenetic, diagenetic and exodiagenetic, katagenetic and multistage deposits. Polygenetic deposits are classified as a separate group. Different productivity of lithogenesis stages is due to inequality of the ore-formation conditions. Diagenesis, exodiagenesis, early katagenesis, and regressive epigenesis in non-metamorphized sedimentary strata are most favorable for uranium concentration, while the late katagenesis and metagenesis stage are not. Superimposition of ore-formation processes of different stages and phases of lithogenesis (multistage nature) as well as combination of deep uranium sources with surface rock- and ore-formation (polygeneity) are characteristic of many uranium deposits in sedimentary cover rocks.

222 **Uranium distribution in concretionary platform phosphorites.** Berzina, I.S.; Karpova, M.I.; Kharitonova, R.Sh. No. 2, 90-98(Apr 1976). (In Russian).

The results are presented of the study of spatial distribution of uranium in the Vyatsk-Kama phosphorite-bearing deposits with a f-radiography method. It has been found that the uranium content in the phosphorites depends largely on the nature and properties of associating minerals and on its redistribution in stream sediments at various stages of diagenesis. Uranium is concentrated mostly together with phosphate material. The two components are subsequently distributed actively as a result of diagenetic processes. At the moment of the joint deposition of phosphate and uranium, a certain catalyzing role is played apparently by organic matter. It appears that apart from the phosphate matter, glauconite proves to be an additional carried of uranium, which involves the latter at the earliest and final stages of diagenesis of sediment. The study of the confinement of uranium to the basic mineral components of phosphorites may help in future to clarify the cause of breaking the correlative links of Vsub(c)Psub(2)Osub(5) which have a great practical value in prospecting, exploration and mining of phosphorite deposits.

223 **Peculiarities of subsurface uranium concentrations in the arid regions.** Kochenov, A.V.; Chernikov, A.A. No. 1, 139-147(Feb 1976). (In Russian).

For English translation see the journal Lithol. Miner. Resour.

The general features of uranium distribution in the zone of hypergenesis of the area under investigation suggest a lack of accumulations due to climatic or landscape factors alone and formed at the expense of background near-clark contents of uranium in primary rocks. The low uranium concentrations in the debris layer of weathered crusts of acidic effusive rocks and granites as well as in salt marshes are of areal distribution and, in practice, never recorded as anomalies. The processes of salt formation in the area discussed appear, in the absence of organic matter in the sediments, to be insufficient by themselves for the accumulation of uranium from its near-clark contents in the primary rocks. At the same time the arid conditions are undoubtedly favorable for the formation and persistence of accumulative diffusion aureoles emphasizing and revealing on the surface the smallest and poorest primary concentrations of uranium. It is inadmissible to extrapolate the results of a study of one area to the entire variety of geomorphological conditions of the arid zone. The data reported show that care should be taken in interpreting uranium anomalies in arid areas, by all means taking account of the geological structure of the particular anomalous area and the uranium resources of the primary rocks.

224 **Structural and geological features of uranium deposits in subsidence calderas.** Nevskii, V.A.; Laverov, N.P.; Tolkunov, A.E. **40**: No. 2, 155-161(Feb 1976). (In Russian).

9 refs.; for English translation see the journal Sov. J. At. Energy.

The hydrothermal deposits of uranium-molybdenum formation are exhibited in calderas of two types. The calderas of the first type are formed of volcanic sheets, and the caldera fault bounding them has appeared within the latest period of volcanism evolution. The uranium deposits are spaced in the interior portion of the caldera. The calderas of the second type are formed by extrusive domes and subvolcanic bodies. The edge annular fault, along which a subsidence caldera appeared later on, was formed at the very beginning of the igneous activity. The uranium deposits are spaced in the dome-like volcanos in the region of the edge annular fault where it is intersected by tectonic fractures. In the calderas of both types the deposits exhibit a spacious relation to deep volcanic channel-ways that had been developing for a long period of time and later-on played the role of mineralizing systems.

225 **Uranium resources: the Canadian status.** Runnalls, O.J.C. (Dept. of Energy, Mines, and Resources, Ottawa). pp 171-192 of In Nuclear power development and the fuel cycle. Farmakes, R. (ed.). Hinsdale, IL; American Nuclear Society, Inc. (1976).

From 1. Pacific Basin topical conference on nuclear development and the fuel cycle; Honolulu, Hawaii, United States of America (USA) (11 Oct 1976).

See CONF-761014—.

The history of the uranium industry in Canada is reviewed beginning with the first discoveries and progressing through the booming years of the 1950's, the doldrums of the 1960's, to the present bouyant seller's market and the promising prospects for new discoveries. The upsurge in demand has led to the establishment of a uranium export policy which is described in detail. Recent estimates of resources, production capacity, and domestic demand are also outlined. Finally, a brief description of the utilization of natural uranium in CANDU power reactors is presented.

226 Influence of gentle ruptures on localization of uranium mineralization in subvolcanic intrusive liparites. Zaporozhets, A.A.; Kantsel, A.V.; Orlovskii, N.B.; Tolkunov, A.E. No. 11, 128-131(Nov 1975). (In Russian).

For selective English translation see the journal Int. Geol. Rev.

Ore bodies associated with gently sloping faults are characterized by original zoning. In the upper parts they are represented by persistent linear-fracture zones; when approaching the gently sloping faults of the ore-containing rocks decrease in size their number increases, and the ore bodies acquire a stockwork structure with predominance of gently sloping tectonic cracks in the stockworks. In the authors' opinion, these features of the structure of the ore bodies are inherent in many hydrothermal uranium deposits confined to subvolcanic and vent facies of liparites. Their study may prove useful in elucidating the conditions of formation of deposits and evaluating their prospects.

227 Critical sizes of fossil natural reactors. Garzon Ruiperez, L. (Oviedo Univ. (Spain). Escuela Tecnica Superior Ingenieros de Minas). **71**: No. 4, 319-320(Oct 1975). (In Spanish).

Starting from a ore deposit constituted by a enriched uniformly dispersed UO_2, into a standard granite matrix, the critical dimensions as a function of certain parameters have been deduced.

228 Densities of fission tracks in natural detectors. Garzon Ruiperez, L. (Oviedo Univ. (Spain). Escuela Tecnica Superior Ingenieros de Minas). **71**: No. 4, 314-318(Oct 1975). (In Spanish).

6 refs.

Considering a solid track recorder placed inside a standard uranium mineral, the ratio r = rhosub(I).rhosup(S)^-1 between the induced tracks densities produced by the internal flux and those produced by the spontaneous fission of the ^{238}U contained in the detector have been studied as a function of certain parameters.

229 ^{233}U content in thorium minerals. Garzon Ruiperez, L. (Oviedo Univ. (Spain). Escuela Tecnica Superior Ingenieros de Minas). **71**: No. 3, 244-248(Jul 1975). (In Spanish).

10 refs.

Starting from an ore model constituted by a uniformly dispersed ThO_2 into a granite matrix, the $^{233}U/Th$ ratio as a function of ThO_2 concentration have been deduced.

230 Criticality of uranium deposits. Garzon Ruiperez, L. (Oviedo Univ. (Spain). Escuela Tecnica Superior Ingenieros de Minas). **71**: No. 1, 75-81(Jan 1975). (In Spanish).

12 refs.

Starting from an ore deposit model constituted by uniformly dispersed UO_2 in a standard granite matrix, some conditions by which a neutron fission chain reaction might be developed in a uranium ore deposit have been deduced.

231 Problem of uranium translocation in hydrothermal environment (from experimental data). Korolev, K.G.; Rumyantseva, G.V.; Golikova, G.A. No. 10, 102-113(Oct 1974). (In Russian).

For English translation see the journal Bull. Acad. Sci. USSR, Geol. Ser.

Reactions of uranyl compounds with distilled H_2O and aqueous solutions of $NaHCO_3$, Na_2CO_3, NaOH, $(NH_4)_2CO_3$, NaF, NaCl, Na_2SiO_3 at temperatures of 100 to 650°C and a pressure of 500 kg/cm² were studied. The initial solid phases would change in the course of experiments. The hydration of UO_3H_2O and the following dehydration reactions have been recorded: $UO_3xH_2O \rightarrow UO_3x0.8H_2O$ (tsub(trans)approximately150°C), $UO_3x0.8H_2O \rightarrow UO_3x0.5H_2O$ (tsub(trans)approximately 320°C). At temperatures of 450°C to 550°C in alkaline sodium media (solutions of NaF, Na_2CO_3, $NaHCO_3$, Na_2SiO_3) $Na_2U_2O_7$ persists but at higher temperatures it is reduced to the cubic $NaUO_3$ (a=4.12+-0.01 A). Besides $Na_2U_2O_7$, soddyite is also stable at moderate temperature (150°C to 350°C) in 0.1 M solutions of Na_2SiO_3. $Na_4UO_2(CO_3)_3$ is stable at 150°C in a 0.38 M solution of $NaHCO_3$. Analyses of the solution condensates formed above the solid phase show a fall in the uranium concentrations with temperature. At 250°C to 350°C the uranium content of fluoride solutions is higher than in corresponding carbonate media, whereas in alkaline-silicate solutions it is lower. In the temperature range between 100°C and 400°C the uranyl concentrations in the water above the uranium hydroxides are 10sup(-5.26) to 10sup(-5.37) negligibly varying with temperature.

EXPLORATION

232 (GJBX—40(77)) Airborne detector improvement. Schneid, E.J.; Swanson, F.R.; Kamykowski, E.A.; Mendelsohn, A. Mar 1977. Contract EX-76-C-13-1664. 71p. (RE—538). Dep. NTIS, PC A04/MF A01.

Airborne Phoswich detector systems can provide approximately a factor of two increase in detection sensitivity for uranium when compared to existing NaI systems. In this study, experimental and theoretical comparisons were conducted between a large volume NaI detector and a large volume collimated Phoswich detector. Laboratory experiments were conducted to establish the ability of the existing Phoswich detector to provide background and Compton distribution suppression in the 1-3 MeV energy region of interest for this application. These measurements also serve to verify the analytical models used for Phoswich detector design studies. During this study, the two detectors were flown to obtain simultaneous measurements of the potassium, uranium, and thorium concentrations in the vicinity of Lake Winnipesaukee, New Hampshire. The correlation of the flight results with the experimental and computer predictions support the conclusion that a Phoswich detector system can provide approximately a factor of two increase in detection sensitivity.

233 Search for uranium : the role of the Atomic Minerals Division[India]. Udas, G.R. (Department of Atomic Energy, Hyderabad (India). Atomic Minerals Div.). **15**: No. 7, 4-6(Mar 1977).

After explaining the various stages involved in prospecting of uranium ores starting from detecting radioactive anomalies to proving of reserves justifying commercial exploitation, the role of the Atomic Minerals Division of the Department of Atomic Energy in this field is described. The areas which show promise of yielding reasonably assured resources are indicated.

234 Uranium reserves as energy resources. Gaertner, E. **29**: No. 1, 1-7(Jan 1977). (In German).

11 figs.; 15 refs.

After a short survey of the 6 main types of uranium deposits, the fundamentals of prospecting and uranium mining are discussed. The problem of cost - which is a major influencing factor with regard to the future demand - is dealt with in detail.

235 Exploration, mining, and milling of uranium ore in Mexico. Ajuria-Garza, S.; Constantino-Herrera, S. (Instituto Nacional de Energia Nuclear, Mexico City). pp 215-222 of In Nuclear power development and the fuel cycle. Farmakes, R. (ed.). Hinsdale, IL; American Nuclear Society, Inc. (1976).

From 1. Pacific Basin topical conference on nuclear development and the fuel cycle; Honolulu, Hawaii, United States of America (USA) (11 Oct 1976).

See CONF-761014—.

Activities in uranium exploration, mining, and milling in Mexico are reviewed. The total area of Mexico is 1,969,269 km², of which less than 10% is actively being explored for uranium. As of December 1975, total positive reserves were 8000 MT of U_3O_8. About 95% of the national territory is regarded as favorable for geological and geophysical uranium exploration and general prospects for substantial additional reserves are very good. The discovery in Mexico of substantial uranium reserves in acidic volcanic rocks has been a significant development since this type of rock was not generally considered as a suitable geologic environment for uranium. A small mill (80 MT of ore per day) operated from 1969 to 1971 and produced 49 MT of U_3O_8. This mill is on standby and will be reactivated in the future. A new mill based on acid percolation leaching is now nearing completion in Chihuahua in northern Mexico. This mill will process 280 MT of ore per day and will produce 125 MT of U_3O_8 per year starting in 1977. Another new mill based on conventional acid leaching is now scheduled for construction, also in Chihuahua. Metallurgical studies are now underway and the mill should be commissioned by 1979 or 1980. This mill will process 2000 MT of ore per day producing about 800 MT of U_3O_8 per year.

236 Potentiality of using radioactive elements in exploration for tungsten fields. Rafienko, N.I.; Laubenbakh, A.I.; Slavyagina, I.I. pp no.25 p.124-132 of In Gamma-spectrometry methods in exploration and prospecting of mineral raw materials. Moscow; ONTY VNIIYAGG (1975). (In Russian)

3 refs.; 6 tables.

The paper discusses the potentialities of prospecting for tungsten deposits using natural radioactivity (V,Ra,Th,K). Radioactive elements register most clearly those deposits which occur in intrusive rocks and are of a stockwork form or have thick extensive ore zones with strongly pronounced metasomatic changes. The postsomatic process selects radioactive components and is accompanied by accumulation or transport of at least one of them in the metasomatic column. Potassium is the most sensitive radioactive element of those indicating the fact of occurring process of ore formation. Albitiza-

tion and silicification are characterized by a considerable transport of potassium; on the contrary, greisenization and potash spar formation are accompanied by potassium accumulation.

MINING

REFER ALSO TO CITATION(S) 235

237 Uranium - Australia's decision. Canberra, Australia; Aust. Govt. Publ. Serv. (1977). 214p.

Ministerial statements by the Prime Minister, Deputy Prime Minister, Acting Minister for Foreign Affairs, Minister for Aboriginal Affairs, Minister for Environmental, Housing and Community Development and the Minister for Health, concerning Australia's decision to mine and export uranium are presented. Background information setting out the factors which guided the Government in reaching its decision is included. Reference to the findings and recommendations of the Ranger Uranium Environmental Inquiry, nuclear safeguards, health and safety aspects of nuclear power generation, mining and milling safety and the impact of mining on Aboriginal society is also made.

238 Mining and milling for uranium in Japan. Takenaka, S.; Takada, S.; Sugitsue, Y. (Power Reactor and Nuclear Fuel Development Corp., Tokyo). pp 193-214 of In Nuclear power development and the fuel cycle. Farmakes, R. (ed.). Hinsdale, IL; American Nuclear Society, Inc. (1976).

From 1. Pacific Basin topical conference on nuclear development and the fuel cycle; Honolulu, Hawaii, United States of America (USA) (11 Oct 1976).

See CONF-761014—.

In Japan, the Ningyo-toge uranium deposit was discovered in 1955, and the Tono deposit in 1962. Geology of these mines is different from that of other metal mines developed in Japan. Therefore, it appeared that some changes were required in the usual mining methods applied to existing metal mines to mine uranium ore in these deposits. At the Ningyo-toge mine, effective methods were studied for mining the ore, such as the room and pillar method, longwall method, slicing method, and the hydraulic method; as a result, it was determined that a modified long-wall method is the most useful and practicable for recovering uranium ore from this underground sedimentary deposit. Applicatons of in-place and microbiological leaching to these deposits are being studied to secure mine safety and decrease mine pollution. Since 1959, when the Ningyo-toge mine went into operation, no hazards for workers nor any pollution of the environment were permitted. Research and development on uranium processing in Japan commenced at the Tokai Works (PNC) in 1956. As a result, the PNC process, which produced reactor-grade uranium directly from ore without the step of yellow cake production, was developed. Since then various improvements and variations of the PNC process have been achieved at the Tokai Works and the Ningyo-toge mill. Following this process, PNC is constructing a UF_6 conversion test facility at the Ningyo-toge mine. A new laboratory for uranium ore processing will be constructed by PNC at the same site in 1977.

239 Environmental aspects of uranium mining and milling in Australia. Davy, D.R. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). pp 347-377 of In Nuclear power development and the fuel cycle. Farmakes, R. (ed.). Hinsdale, IL; American Nuclear Society, Inc. (1976).

From 1. Pacific Basin topical conference on nuclear development and the fuel cycle; Honolulu, Hawaii, United States of America (USA) (11 Oct 1976).

See CONF-761014—.

The environmental aspects of uranium mining and milling in Australia are discussed in terms of the early history of uranium mining and recent discoveries of substantial reserves. It is concluded that the major environmental impact associated with uranium mining and milling, particularly for developments in semiarid areas, is in no way unique; it is heavy-metal contamination and not radioactivity that causes concern. Provided the exposure of miners to radon daughters is controlled and attention given to other minor potential radiological aspects of the operation, the engineering solutions for environmental restraints should be the same as those required for a similarly located base-metal mine.

FEED PROCESSING

REFER ALSO TO CITATION(S) 235, 238, 239

240 (ORNL/TM—5913) Laboratory and pilot-plant studies on the conversion of uranyl nitrate hexahydrate to UF_6 by fluidized-bed processes. Youngblood, E.L.; Urza, I.J.; Cathers, G.I. Jun 1977. Contract W-7405-ENG-26. 64p. Dep. NTIS, PC A04/MF A01.

This report describes laboratory and pilot-plant studies on the conversion of uranyl nitrate hexahydrate (UNH) to UF_6 and on purification of the UF_6. Experimental laboratory studies on the removal of residual nitrate from uranium trioxide (UO_3) calcine and the fluorination of technetium and subsequent sorption on MgF_2 were conducted to support the pilot-plant work. Two engineering-scale pilot plants utilizing fluidized-bed processes were constructed for equipment and process testing of the calcination of UNH to UO_3 and the direct fluorination of UO_3 to UF_6.

241 Uranium production. Roux, A.J.A. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). **18**: No. 11, 42(Nov 1976).

Published in summary form only.

242 Bacterial oxidation to raise uranium extraction rate. 88: No. 4127, 61-63(Apr 1977).

Bacteria is being used by General Mining and Finance Corp. for the oxidation of ferrous iron, a process which is expected to raise the uranium extraction rate by four per cent while cutting operating costs by eight per cent.

243 R85m President Brand joint metallurgical complex. Payne, A. **88**: No. 4127, 29-35(Apr 1977).

The uranium plant at President Brand, which was built in 1971 and opened last year, is now being extended. The plant forms only part of the extensive joint metallurgical complex being developed by Anglo American Corp. in the Free State, costing a total R85million. This article examines technical details of the recovery processes involved.

244 Method for manufacturing uranium dioxide capable of being sintered. Welty, R.; Richland, K. (to Exxon Nuclear Co., Inc., Bellevue, Wash. (USA)). German(FRG) Patent 2,532,821/A/. 10 Feb 1977. 14p. (In German).

An improvement of the method for conversion of uranium hexafluoride to uranium dioxide capable of being sintered by means of a multi-step fluidized bed process is proposed. In the first step, uranyl fluoride in solid state is formed from uranium hexafluoride and steam which is then converted to triuranium octoxide at temperatures above 730°C, the latter being subsequently fluidized at temperatures below 500°C and reduced to UO_2 with excess hydrogen in the presence of steam. Variants of the process steps are described. The fluoride content of the final product lies below 0.011 w%.

245 Method of producing granulated ceramic nuclear fuels. Wilkinson, W.L. (to UKAEA London Office). German(FRG) Patent 1,592,536/C/. 26 May 1976. 6p. (In German).

1 fig.

For the production of granulated ceramic nuclear fuels with a grain size spectrum as narrow as possible it is proposed to suspend the nuclear fuel powder in a non-aqueous solvent with small content of hydrogen (e.g. chloridized hydrocarbons) while adding a binding agent and then dry it by means of rays. As binding agent polybutyl methane acrylate in dibutyl phthalate is proposed. The method is described by the example of UO_2-powder in trichloroethylene. The dry granulated material is produced in one working step.

ENRICHMENT

246 Methods and devices for the separation of gaseous or vaporous substances, especially isotopes, with the aid of separation nozzles. Becker, E.W.; Eisenbeiss, G.; Ehrfeld, W. (to Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (Germany, F.R.)). German(FRG) Patent 2,338,893/B/. 16 Dec 1976. 13p. (In German).

An improvement of the separation nozzle method for separating isotopes is proposed with the economy of the process being considerably improved. This is achieved by deflection by means of peeling diaphragms within the column so that the spaces of the separation nozzle system filled with centrifugal acceleration will contribute more to the separating process than they have done until now. The individual measures are presented in detail with the aid of 13 drawings.

247 Vortex nozzle method for uranium enrichment. Fuhse, W. German(FRG) Patent 2505864/A/. 14 Oct 1976. 9p. (In German).

It is proposed to replace the known separation nozzle enrichment process for separating uranium isotopes by a vortex nozzle process where, by tangential inflow of a gas jet into a tube, eddies are produced and the isotopes separate under the influence of centrifugal forces. By adding a light gas the effect is intensified to such a degree that large-scale industrial application is possible. It is advantegeous if the tube has a contraction so that a supersonic jet is

produced in the way of a Laval nozzle. Various geometric variants are described which are thought to increase the output.

248 Centrifuge enrichment program. Astley, E.R. (Exxon Nuclear Co., Inc., Bellevue, WA). pp 245-259 of In Nuclear power development and the fuel cycle. Farmakes, R. (ed.). Hinsdale, IL; American Nuclear Society, Inc. (1976).

From 1. Pacific Basin topical conference on nuclear development and the fuel cycle; Honolulu, Hawaii, United States of America (USA) (11 Oct 1976).

See CONF-761014—.

Exxon Nuclear has been active in privately funded research and development of centrifuge enrichment technology since 1972. In October of 1975, Exxon Nuclear submitted a proposal to design, construct, and operate a 3000-MT SWU/yr centrifuge enrichment plant, under the provisions of the proposed Nuclear Fuel Assurance Act of 1975. The U.S. Energy Research and Development Administration (ERDA) accepted the proposal as a basis for negotiation. It was proposed to build a 1000-MT SWU/yr demonstration increment to be operational in 1982; and after successful operation for about one year, expand the facilities into a 3000-MT SWU/yr plant. As part of the overall centrifuge enrichment plant, a dedicated centrifuge manufacturing plant would be constructed; sized to support the full 3000-MT SWU/yr plant. The selection of the centrifuge process by Exxon Nuclear was based on an extremely thorough evaluation of current and projected enrichment technology; results show that the technology is mature and the process will be cost effective. The substantial savings in energy (about 93%) from utilization of the centrifuge option rather than gaseous diffusion is a compelling argument. As part of this program, Exxon Nuclear has a large hardware R and D program, plus a prototype centrifuge manufacturing capability in Malta, New York. To provide a full-scale machine and limited cascade test capability, Exxon Nuclear is constructing a $4,000,000 Centrifuge Test Facility in Richland, Washington. This facility was to initiate operations in the Fall of 1976. Exxon Nuclear is convinced that the centrifuge enrichment process is the rational selection for emergence of a commercial enrichment industry.

CENTRIFUGATION

249 Combined laser centrifugal isotopic separation technique. Winterberg, F. (Nevada Univ., Reno (USA). Desert Research Inst.). **30**: No. 1, 65-66(1977).

Short communication only.

250 Uranium enrichment by centrifuge in Japan. Nakamura, Y.; Tamai, K. (Power Reactor and Nuclear Fuel Development Corp., Tokyo). pp 261-271 of In Nuclear power development and the fuel cycle. Farmakes, R. (ed.). Hinsdale, IL; American Nuclear Society, Inc. (1976).

From 1. Pacific Basin topical conference on nuclear development and the fuel cycle; Honolulu, Hawaii, United States of America (USA) (11 Oct 1976).

See CONF-761014—.

Evaluation of the enrichment pilot plant program by the centrifuge process is being carried out this year. The centrifuge process, on which studies were started in 1959, has made rapid progress since 1972 when it was designated a national project of Japan, resulting in drastically improved performance and economics of centrifuges and cascade systems. On the basis of the technical achievements so far attained in the uranium enrichment industry, and the centrifuge process specifically, one can note the many characteristic differences from other industries. Results are presented of studies on various aspects relating to the centrifuge technology, demands for enriched uranium, financing considerations on plant construction funds, etc.

LASER EXCITATION

251 (COO—4118-1) Uranium isotope separation in the solid state. Progress report, December 1, 1976—June 1, 1977. Bernstein, E.R. Jun 1977. Contract EY-76-S-02-4118. 8p. Dep. NTIS, PC A02/MF A01.

Since we were actively able to work on this project, we have been engaged in three separate lines of research. Each of these has been related to laser-induced isotope separation of uranium in the solid state. The three areas are: (a) improved reaction chemistry for both host materials $Zr(BH_4)_4$ and $Hf(BH_4)_4$ and $U(BH_4)_4$ itself; (b) improved spectroscopic techniques in order to obtain sharper spectra; and (c) solid state photochemical investigations to study $U(BH_4)_4$ photodecomposition mechanism and yield as a function of wave length. These are all integral parts of the solid state isotope separation procedure and are discussed in terms of the overall process proposed.

252 (UCRL—13737) Ion extraction system study. Final report. Hyman, J. Jr.; Williamson, W.S. May 1977. Contract W-7405-ENG-48-2963703. 77p. Dep. NTIS, PC A05/MF A01.

Results of an 8-month study of plasma-extraction processes for laser isotope separation of uranium are reported. A simulation technology was developed, using mercury instead of uranium, and analytical and experimental studies of plasma-extraction processes were performed in the context of mercury simulation. (LK)

253 Method and device for isotope separation. Woodroffe, J.A.; Keck, J.C. (to Jersey Nuclear-Avco Isotopes, Inc., Bellevue, Wash. (USA)). German(FRG) Patent 2627995/A/. 27 Jan 1977. 33p. (In German).

The paper describes a method to separate the isotopes from gaseous compounds by means of selective excitation by laser radiation. Gaseous UF_6 is led through a cooling chamber with a carrier gas current (e.g argon) of high density ($3 \times 10^{14}/cm^2$). There, it is irradiated with laser radiation, then led to deep-frozen collector surfaces. During this process, the excited molecules get condensed and thus increase. After a certain time the current is interrupted and the enriched fraction separated. The method and the devices it demands are described in detail (64 claims).

254 Method for isotope separation. Krieg, G.; Obert, W. (to Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (Germany, F.R.)). German(FRG) Patent 2528953/A/. 13 Jan 1977. 9p. (In German).

An improvement is proposed of methods for the separation of isotopes from gaseous compounds by selective excitation with the aid of radiation (laser or natural light source), where the separating effect is increased by taking full advantage of an intensive broadband radiation spectrum and achieving a high density of molecules. This is achieved by selecting isotopes with a shifting of band edges in their absorption spectra because of the isotopic effect and by applying a frequency range for the exciting radiation containing frequencies exclusively exciting the desired isotope in a fully selective way. As an example, the separation of ^{238}U and ^{235}U from UF_6 is mentioned.

255 Method for the enrichment of isotopes. Schuster, E.; Kersting, A.; Gebauhr, W. (to Kraftwerk Union A.G., Muelheim an der Ruhr (Germany, F.R.)). German(FRG) Patent 2524027/A/. 2 Dec 1976. 7p. (In German).

A method for the enrichment of isotopes, especially of uranium compounds, is described, working according to the principle of selective excitation by laser beams. As the starting compound, UF_6 is mentioned; the reaction partness are atomic gases (hydrogen, oxygen, nitrogen) or radicals (CH_3, CHO). According to the invention, the gas mixture flows through the reaction space with a velocity so large that in leaving it, recombination of the reaction partner will already take place again. In this way, competing thermal reactions will be avoided and energy transfer fo excited ^{235}U molecules to non-excited ^{238}U molecules is eliminated to a large extent. A suitable equipment for implementing the method is described.

256 Method for isotope separation. Schuster, E.; Niemann, H.J.; Kersting, A. (to Kraftwerk Union A.G., Muelheim an der Ruhr (Germany, F.R.)). German(FRG) Patent 2524128/A/. 2 Dec 1976. 7p. (In German).

The inventor proposes a method for separating isotopes from gaseous compounds by selective excitation by means of laser beams for such cases where the reaction partners each consist of several isotopes. For example, separation of ^{235}U and ^{238}U in the form of UCl_6 is mentioned with ^{35}Cl and ^{37}Cl existing in the natural composition of 76:24. According to the invention, after isolating the reaction product obtained in a way already known, the remaining fraction of the compound mixture is brought together with the reaction partner present in the nautral isotope composition, in a heated flow path. Thereby by isotope exchange of the latter regeneration will take place, and the mixture can pass again through the separation plant in initial composition.

257 Method for the separation and enrichment of isotopes. Niemann, H.J. (to Kraftwerk Union A.G., Muelheim an der Ruhr (Germany, F.R.)). German(FRG) Patent 2517828/A/. 18 Nov 1976. 13p. (In German).

The paper suggests a method for the separation and enrichment of isotopes from gaseous compounds by means of selective excitation caused by radiation (prefarably laser) which is based on compound mixtures which are only short-lived and thus inconstant in their first development stage. The method is described with the example of selective excitation of UF_5 which is first formed by selective conversion. The method is mainly characterized by the fact that the first light source for the photochemical reaction and the second light source for the selective excitation of UF_5 radiate into compound mixture one after another in pulsed operation. Duration and temporal distance of the pulses are adjusted to the speeds of the reactions. The excited short-lived UF_5 is chemically converted to UF_4 with a reaction partner. UF_4 contains the enriched uranium isotope and can be separated in the known form. According devices are briefly described.

258 **Separation process for uranium isotopes.** Lyon, R.K.; Kaldor, A. (to Exxon Research and Engineering Co., Linden, N.J. (USA)). German(FRG) Patent 2616934/A/. 4 Nov 1976. 11p. (In German).

It is proposed to separate uranium isotopes from gaseous UF_6 by selective excitation with infrared light, with at least 0.1% of the $^{235}UF_6$ or $^{238}UF_6$ molecules absorbing an energy higher than 2,000 cm^{-1}. After the excitation step, which is shorter than 10^{-3} seconds, the UF_6 is brought in contact with a gaseous reaction agent (atomic chlorine, bromine, or iodine) for less than 10^{-3} seconds (molar ratio 0.1), and the reaction product is separated off.

259 **Method and device for the enrichment of isotopes.** Stehle, H. (to Kraftwerk Union A.G., Muelheim an der Ruhr (Germany, F.R.)). German(FRG) Patent 2443216/B/. 23 Sep 1976. 3p. (In German).

A variation of a method for isotope enrichment by laser radiation is proposed which improves the selectivity and with it the economy of the method by eliminating undesired reactions caused by thermal activation. The method according to the invention is applied discontinuously in three steps: The isotope mixture and the reacting agents are fed to a vessel, a laser beam is passed through, and the contents are emptied into a vacuum tank while expanding adiabatically. The time steps are controlled. The method is explained using the example of separating an isotope mixture of UF_6.

260 **Isotope separation process.** (to Exxon Research and Engineering Co., Linden, N.J. (USA)). Netherlands Patent 7609843/A/. 3 Sep 1976. Priority date 12 Sep 1975, United States of America (USA). 11p. (In Dutch).

The invention relates to a process for separating a material into two or more parts in each of which the abundances of the isotopes of a given element differ from the abundances of the isotopes of the same material. More particularly, the invention relates to a method for the isotopically selective excitation of gas phase molecules by multiple infrared photon adsorption after which more of the excited molecules than nonexcited molecules are converted to a chemically different form which may be separated by means known in the art. This invention is useful for, but not limited to, the separation of the principal isotopes of uranium.

261 **Separation of isotopes in view of the reaction.** Tanaka, I. (Tokyo Inst. of Tech. (Japan). Faculty of Science). No. 12, 312-317(Jun 1976). (In Japanese).

From 12. Japan conference on radioisotopes; Tokyo, Japan (26 Nov 1975).

The isotope separation by using laser beam is reviewed on the standpoint of photochemistry. Resonance lamp beam is compared with the laser beam. The width of the beam emitted from the mercury resonance lamp is 0.1/cm, that is similar to the isotope shift, whereas the line width of the laser beam is equivalent to 3 x 10^{-3}/ cm, therefore the spectrum lines are more sharp than that of the mercury lamp. The argon ion laser can emit the output of 10 watt per square centimeter at 4,888 angstrom unit. Next, the efficiency of separation is compared between the samples of atoms and molecules. The atoms are more efficient. Further, the physical methods and the chemical methods for separating isotopes at the excited conditions of atoms are compared. In the one step exciting method, the development of most strong laser of short wave length is desirable. In the chemical methods, the experimental researches on the reactions of hydrogen, oxygen and halogens with uranium under the conditions of either ground state of excited state are necessary. There is some possibility to use free radicals beside atoms and molecules. The isotope shift of the free radicals of two atoms is clear, because they have the more sharp spectra than that of molecules of UF_6.

FUELS PRODUCTION AND PROPERTIES

REFER ALSO TO CITATION(S) 245, 1162, 1163

262 (EPRI-NP—404) **Radioactivity in mixed oxide fabrication using LWR recycle plutonium. Final report.** Uotinen, V.O.; Harrison, J.L.; Caldwell, C.S.; Kerr, J.M.; Woods, C.R. Apr 1977. 220p. Dep. NTIS, PC A10/MF A01.

A study was conducted to evaluate expected isotopics and radiation emitted from plutonium generated in light water reactors. The impact of expected radiation fields on the techniques used to fabricate plutonium recycle fuel has also been evaluated. An extensive survey of past experience with plutonium fabrication was included as a part of the study. The major conclusion is that a conventional plant concept in which most routine operations are mechanized represents a satisfactory design for a mixed oxide fabrication facility if certain conditions are satisfied. The most important of these conditions are that (1) current regulatory exposure limits are not significantly reduced, (2) the time from ^{241}Am separation to fuel fabrication does not exceed about two years, and (3) the levels of ^{236}Pu are not appreciably greater than a few ppM in plutonium. If these conditions are appreciably exceeded, various degrees of remoting will be required. 17 figures, 29 tables.

263 **Study of reactions between simulated solid fission products and ThO_2.** Leigh, H.D.; McCartney, E.R. (New South Wales Univ., Kensington (Australia). Dept. of Ceramic Engineering). **13**: No. 1, 12-16(May 1977).

Thoria specimens containing oxide and metallic components to simulate a thoria-based fuel element after high fission burnup were studied. Simulation techniques involving isothermal and non-isothermal heat treatment were employed. The results of this study were compared with those from post-irradiation examination studies on urania-based fuels. As with real UO_2-based fuel elements after high burnup, barium zirconate-type phases were found to be stable in the thoria matrix at least up to 1600°C; however, in the ThO_2 system, a $Nd_2Zr_2O_7$ synthetic pyrochlore-type phase, not found with UO_2, was detected. It appeared that formation of this phase was favoured over the formation of barium zirconate under reducing conditions. Under the influence of a high thermal gradient the simulated fuel elements appeared to show centre core melting and equiaxed grains but failed to show columnar grain formation.

264 **Prediction of the thermal conductivity of UO_2 vapor.** Tills, J.L.; Cronenberg, A.W. (New Mexico Univ., Albuquerque (USA). Dept. of Nuclear Engineering); Schmidt, T.R. (Sandia Labs., Albuquerque, N.Mex. (USA)). **67**: No. 1, . 67-76(1977).

An important aspect of Liquid-Metal Fast Breeder Reactor (LMFBR) safety analysis is an accurate description of the transport phenomena of the various reactor materials during a hypothetical core-disruptive accident. For the case of an accident sequence leading to fuel vaporization, the problem of energy losses by conduction, radiation, and latent heat and mass losses by condensation of the fuel vapor in the presence of cold structure and/or coolant is of particular interest since such losses will determine, to a large extent, the energetics of the fuel vapor expansion process following pin failure. In this paper, a theoretical estimate of the thermal conductivity of UO_2 vapor is determined, based upon kinetic theory for a multicomponent gas. Results indicate that at elevated temperatures, the conductivity is a strong function of temperature due to thermal dissociation of the UO_2 molecule, where the species concentrations are taken from calculations presented elsewhere. At 5000 K the thermal conductivity is $2.2x10^{-3}$ cal/cm-sec K, which is relatively high; thus, it should be considered in analyses of fuel vapor phenomenon. The functional relationship between conductivity and temperature can be approximated as: lambdasub(t) = exp[-39.66+1.891(-2)T-3.561(-6)T^2+2.242(-10)T^3], for 3000 K<=T<=5500 K.

265 **Method to produce metal oxide or metal carbide particles.** Zimmer, E. (to Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.)). German(FRG) Patent 2,323,072/C/. 30 Dec 1976. 3p. (In German).

Spherical particles of high density, serving as fuel or fertile material for nuclear reactors, may advantageously be fabricated from aqueous initial solutions containing metal salts, to which are added, according to the invention, about 1-3 moles of an ammonium salt and 2-6 moles of urea per mole of metal ions contained therein. It is also of advantage to add ammonia. This initial solution is dropped in known fashion into an organic phase standing above an aqueous ammonia solution and being prepared from a ketone mixture, during which process the desired metal oxide metal carbide particles will be formed. The example is based on a solution containing uranyl nitrate, ammonium nitrate, and urea.

266 **Method for manufacturing directly extrudable, fluid granulated material from uranium dioxide, free of binding agent, with good sintering capability.** Hackstein, K.; Mueller, N. (to Nuklear-Chemie und -Metallurgie G.m.b.H. (NUKEM), Hanau (Germany, F.R.)). German(FRG) Patent 1,592,468/C/. 23 Dec 1976. 1p. (In German).

A method is described for manufacturing directly extrudable, fluid granulated uranium dioxide, free of binding agent, with good sintering properties from a non sinta-active uranium dioxide powder. According to the given process, the uranium dioxide powder is activated by fine grinding to grain sizes of < = 1 μm up to 5 μm and subsequently dry-granulated to obtain round particles. The granulated material may then be extruded to forme pellets and sintered.

267 **Influence of small additions on the preparation and the properties of UO_2 ceramics. Part B. The UO_2-TiO_2 system.** Inzenhofer, A. (Kraftwerk Union A.G., Erlangen (Germany, F.R.). Abt. Brennelement-Technologie). **109**: No. 12, 728-731(Dec 1976). (In German).

2 figs.; 1 tab.; 17 refs.

In the present part B of the literature survey on the effect of oxide additions on the behaviour of UO_2, the influence of titanium oxide is dealt with. Firstly, a few important basic data of the two-phase system UO_2-TiO_2 are given: phase diagram, diffusion constants, flexural strength. The sinter behaviour and the grain growth

are then treated. In particular, the question of at which temperature a malten phase forms and this then contributes to an increase of the sintering rate is answered.

268 Method to measure the oxygen-to-metal ratio in oxidic nuclear fuels. Vollath, D. (to Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (Germany, F.R.)). German(FRG) Patent 2,518,805/A/. 4 Nov 1976. 17p. (In German).

4 figs.; 1 tab.

A method to measure the oxygen-to-metal ratio in oxidic nuclear fuels is proposed which is very exact, requires only a short measuring time, and can be automated. At temperatures between 650°C and 1,300°C, the oxygen potential of the nuclear fuel is measured electrochemically using a solid electrolyte and a reference substance with known oxygen potential. The result is derived by computer from the measured value and a calibration curve. A suitable solid electrolyte is a thorium oxide doped with yttrium oxide and calcium oxide. The arrangement to carry out the measuring process is described in detail; a very suitable measuring chain is Pt - Fe/FeO - $ThO_2(Y_2O_3$, CaO) - ZrO_2(CaO) - $ThO_2(Y_2O_3$, CaO) - sample - Pt.

269 Fabricating fuel elements. Schneider, V.W. (Alpha Chemie und Metallurgie G.m.b.H. (ALKEM), Hanau (Germany, F.R.)); Ploeger, F. (Reaktor-Brennelement Union, Hanau (Germany, F.R.)). **100**: No. 11, 475-483(Nov 1976). (In German).

4 figs.; 3 tabs.; 25 refs.

Following a short review of the design criteria for LWR and LMFBR-fuel elements as well as of the construction of the elements and the materials used, the fabrication of the elements for LWR is described both for pelletized UO_2-fuel and for pelletized UO_2-PuO_2-fuel. Finally the further R+D-work in the field of fuel elements is summarized.

270 Influence of small additions to the preparation and the properties of UO_2 ceramics. Part A. UO_2/Gd_2O_3. Inzenhofer, A. (Kraftwerk Union A.G., Erlangen (Germany, F.R.). Abt. Brennelement-Technologie). **109**: No. 9, 510-513(1976). (In German).

1 fig.; 15 refs.

The effects of oxide additions on the preparation and burn-up behaviour fo UO_2 fuels is presented within the framework of a literature survey. In the present part A, the addition of Gd_2O_3 (max. 5 wt.%) is dealt with. Firstly a few crystallographic data are given: phase diagrams, lattice parameters, coefficient of expansion. The preparation of UO_2-Gd_2O_3 sinter bodies is then treated. The melting point of UO_2 is somewhat lowered by the addition of Gd_2O_3, the lattice constants become smaller.

271 Method of uranium-containing ores processing into uranium compounds. Got'e Reneh. USSR Patent 482,939/A/. 30 Aug 1975. Priority date 22 Oct 1968, France. 2p. (In Russian).

The method of uranium-containing ores processing has been developed which yields the uranium compounds through interaction of the initial product with a sulfate ammonium compound upon heating with subsequent extraction of the uranium compounds from the reaction products. To simplify the process and reduce the consumption of the reagents, the interaction of the initial product with ammonium bisulfate is performed in an aqueous phase at 100-200°C.

272 Nuclear criticality safety: current theory and practice. Alcorn, F.M. (Babcock and Wilcox Co., Lynchburg, VA). pp 78-92 of In Nuclear safety, 1975. Hetrick, D.L. (ed.). Hinsdale, IL; American Nuclear Society (1975).

From ANS topical meeting on nuclear safety; Tucson, Arizona, USA (5 Oct 1975).

See CONF-751044—.

This paper presents the nuclear criticality safety discipline to the novice; it presumes some basic knowledge of the nuclear industry and the concept of fission and of a nuclear chain reaction. The paper emphasizes state-of-the-art and current practice in general terms. The intent of the paper is to equip those outside the discipline with the basic concepts as an aid to understanding safety of the total nuclear fuel cycle. It is also hoped that those outside the discipline who may interface with nuclear criticality safety will have a better appreciation of nuclear criticality safety and its role.

SPENT FUELS REPROCESSING

REFER ALSO TO CITATION(S) 356, 711, 1202

273 (ORNL/TM—4716) **Cerium-promoted dissolution of PuO_2 and PuO_2—UO_2 in nitric acid.** Horner, D.E.; Crouse, D.J.; Mailen, J.C. Jun 1977. Contract W-7405-ENG-26. 41p. .

Several experiments were run to determine the feasibility of using cerium as an alternative to fluoride in promoting rapid dissolution of difficultly soluble PuO_2 in nitric acid. Results show that Ce^{4+}, but not Ce^{3+}, promotes dissolution with a maximum rate in boiling 4M HNO_3. Other strong oxidants, including ozone, permanganate, and persulfate, were tested but were shown to be ineffective. During dissolution, the Ce^{4+} is reduced to Ce^{3+}, which must be reoxidized electrolytically or with ozone. Ruthenium also reduces the Ce^{4+} catalytically, being oxidized to the volatile RuO_4. Thus successful application to dissolution of irradiated fuel residues would require modification of the equipment or procedures in such a way as to encourage complete volatilization of ruthenium from the dissolver system. However, application of this method to the treatment of plutonium appears promising.

274 (UCID—17453) **Seismic analysis of the Nuclear Fuel Service Reprocessing Plant at West Valley, New York: documentation.** Murray, R.C.; Nelson, T.A.; Davito, A.M. 26 Apr 1977. Contract W-7405-ENG-48. 387p. Dep. NTIS, PC A17/MF A01.

This material was generated as part of a seismic case review of the NFS Reprocessing Plant. This study is documented in UCRL-52266. The material is divided into two parts: mathematical model information, and ultimate load calculations and comparisons. (DLC)

275 Activities of the Scientific and Technical Coordination Council for Reprocessing of Irradiated Nuclear Fuel. Semlyanukhin, W.I. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow). **13**: No. 3, 102-103(Mar 1977). (In German).

Translated from Atomnaya Ehnergiya (1976)v. 40 p. 181.

A brief survey of the activities of the Scientific and Technical Coordination Council (STCC) of the CMEA Permanent Commission for the Peaceful Uses of Atomic Energy is presented according to the programme 1971 to 1975. The work of the STCC was focused on the following problems: preparation of fuel elements for reprocessing (including determination of fission products and transport), aqueous and fluoride volatility processes in reprocessing, methods for control of technological processes, economy, and environmental protection. The topics of the research programme for the period 1976 to 1980 are listed.

276 (ORNL-tr—4412) **Plutonium recycling in light-water reactors: fuel burn-up calculations for the design of reprocessing plants and the effects on uranium requirements.** Gasteiger, R. 28 Jan 1977. Translation by K.S. Warren of KFK—2417. 22p. Dep. NTIS, PC A02/MF A01.

This report gives a detailed review on the composition of radionuclides in spent LWR fuel in the case of Pu-recycling. These calculations are necessary for the design of spent fuel reprocessing plants. Furthermore the influence of Pu-recycling on the demand of uranium for a single LWR as well as for a certain growing LWR-population is shown. 11 figures, 4 tables.

277 Management of waste from nuclear power plants - an ecol0gical necessity. Fuel cycle - reprocessing - plutonium recycling - final storage. Schueller, W. (Gesellschaft zur Wiederaufarbeitung von Kernbrennstoffen m.b.H., Eggenstein-Leopoldshafen (Germany, F.R.)). **77**: No. 2, 41-49(Jan 1977). (In German).

10 figs.; 6 refs.

In view of the rapidly declining supplies of fossil fuels, in particular oil and gas, our growing energy demand can only be met by exploration of nuclear fission, at least for an interim period of 50 to 100 years, until the time when solar or fusion energy will become available. Operation of nuclear power stations requires the installation, on an industrial scale, of the nuclear fuel cycle. This paper covers the so-called back-end of this cycle, including transportation, interim storage, and chemical reprocessing of irradiated fuel elements, recycling of plutonium and the conditioning and disposal of radioactive waste in geological salt formations. The author expresses the opinion, that in spite of a number of controversial issues - like the hazard potential fo plutonium, the long-term storage of radioactive waste, plant safety and nuclear weapons proliferation risk - the environmental requirements of nuclear energy generation can be adequately solved.

278 Measuring density on-line to nuclear industry standards. Bond, A. **9**: No. 7, 22-23(1977).

An on-line system of ultrasonic density measurement which has been developed with the severe limitations of access and reliability imposed by the nuclear fuel reprocessing environment is described. The ultrasonic transducer is introduced into a thimble which passes through several feet of concrete biological shielding and is coupled to the associated electronic instrumentation, based on the modular Harwell 6000 series, which excites the transducer with short high-voltage pulses causing it to emit the necessary high-frequency ultrasonic pulses. Such equipment can be used in a fuel reprocessing environment not only for the original requirement of measuring the concentration of uranium and plutonium in a slowly flowing stream of organic solvent, TBP/OK, but also for measuring the position of liquid surface levels and liquid/liquid interfaces in large vessels.

279 Method for the processing of block-shaped graphite fuel elements. Hackstein, K.G.; Spender, G. (to Hochtemperatur-Reaktor-Brennelement G.m.b.H. (HOBEG), Hanau (Germany, F.R.)). German(FRG) Patent 1,423,611/C/. 4 Nov 1976. 2p. (In German).

A method is described for the mechanical crushing and reprocessing of non-irradiated or irradiated block-shaped graphite fuel elements, in particular for those in which the cooling channels and fuel zones in the graphite block are distributed in grid shape next to each other. Conical pins are simultaneously pressed into several cooling channels until the block is broken up along the entire length of the cooling channels to mechanically crush the prismatic graphite blocks. The shape of the pins and their ordering in performing the method are part of the invention. Breeder and burn-up fuel rods are separated from one another after breaking and are individually processed according to known methods.

280 Optimal installation program for reprocessing plants. Kubokawa, T.; Kiyose, R. (Tokyo Univ. (Japan). Faculty of Engineering). **13**: No. 11, 633-647(Nov 1976).

Optimization of the program of installation of reprocessing plants is mathematically formulated as problem of mixed integer programming, which is numerically solved by the branch-and-bound method. A new concept of quasi-penalty is used to obviate the difficulties associated with dual degeneracy. The finiteness of the useful life of the plant is also taken into consideration. It is shown that an analogous formulation is possible for the cases in which the demand forecasts and expected plant lives cannot be predicted with certainty. The scale of the problem is found to have kN binary variables, (k+2)N continuous variables, and (k+3)N constraint conditions, where k is the number of intervals used in the piece-wise linear approximation of a nonlinear objective function, and N the overall duration of the period covered by the installation program. Calculations are made for N=24 yr and k=3, with the assumption that the plant life is 15 yr, the plant scale factor 0.5, and the maximum plant capacity 900 (t/yr). The results are calculated and discussed for four different demand forecasts. The difference of net profit between optimal and non-optimal installation programs is found to be in the range of 50 -- 100 M$. The pay-off matrix is calculated, and the optimal choice of action when the demand cannot be forecast with certainty is determined by applying Bayes' theory. The optimal installation program under such conditions of uncertainty is obtained also with a stochastic mixed integer programming model.

281 Safety and environmental aspects of spent-fuel reprocessing. Kiyose, R. (Tokyo Univ.); Kurokawa, Y. pp 379-388 of In Nuclear power development and the fuel cycle. Farmakes, R. (ed.). Hinsdale, IL; American Nuclear Society, Inc. (1976).

From 1. Pacific Basin topical conference on nuclear development and the fuel cycle; Honolulu, Hawaii, United States of America (USA) (11 Oct 1976).

See CONF-761014—.

Design and safety evaluations of reprocessing facilities are discussed, and environmental aspects of these facilities are described, using Japan's PNC reprocessing plant as a principal example. (LK)

282 Regional fuel cycle center in the Far East: the approach from the developing country. Lee, B.W. (Atomic Energy Commission, Seoul). pp 423-426 of In Nuclear power development and the fuel cycle. Farmakes, R. (ed.). Hinsdale, IL; American Nuclear Soccicty, Inc. (1976).

From 1. Pacific Basin topical conference on nuclear development and the fuel cycle; Honolulu, Hawaii, United States of America (USA) (11 Oct 1976).

See CONF-761014—.

Success of the Regional Fuel Cycle Center (RFCC) would substantially alleviate the heavy burden of technology development, manpower training, and financing for fuel cycle requirements among participating countries in the region. The key to success would really depend on how to best accommodate the conflicting interests of different partners and how to best provide economic services. These aspects should be thoroughly studied in the early stages of RFCC formulation from the view of institutional and legal framework as well as from the sociopolitical situations in the region.

283 Japan's spent-fuel reprocessing program and regional planning. Nakajima, T. (Japan Gasoline Co., Ltd., Tokyo). pp 427-431 of In Nuclear power development and the fuel cycle. Farmakes, R. (ed.). Hinsdale, IL; American Nuclear Society, Inc. (1976).

From 1. Pacific Basin topical conference on nuclear development and the fuel cycle; Honolulu, Hawaii, United States of America (USA) (11 Oct 1976).

See CONF-761014—.

A brief summary of Japan's nuclear fuel cycle policy is given. (LK)

284 Regional spent-fuel reprocessing in Asia. Chu, D.S.L. (Taiwan Power Co., Taipei). pp 433-438 of In Nuclear power development and the fuel cycle. Farmakes, R. (ed.). Hinsdale, IL; American Nuclear Society, Inc. (1976).

From 1. Pacific Basin topical conference on nuclear development and the fuel cycle; Honolulu, Hawaii, United States of America (USA) (11 Oct 1976).

See CONF-761014—.

Spent-fuel reprocessing, a necessary link in the fuel cycle for nuclear power generation, is presently missing. This problem is now being confronted by all regional countries in Asia who have nuclear power development commitments. The logical solution appears to be establishment of a regional reprocessing plant through international cooperation among the Asian countries and the host country (U.S.) of this Conference. A preliminary idea concerning establishment of regional facilities is presented for deliberation by the participants of this Conference.

285 Regional nuclear fuel centers: IAEA study project. Meckoni, V.; Catlin, R.; Bennett, L.; Fujii, H.; Pender, J. (International Atomic Energy Agency, Vienna). pp 439-447 of In Nuclear power development and the fuel cycle. Farmakes, R. (ed.). Hinsdale, IL; American Nuclear Society, Inc. (1976).

From 1. Pacific Basin topical conference on nuclear development and the fuel cycle; Honolulu, Hawaii, United States of America (USA) (11 Oct 1976).

See CONF-761014—.

The concept of regional nuclear fuel cycle centers has attracted wide interest. This concept envisages countries joining together for the purpose of planning, constructing, and operating integrated facilities which are necessary to receive spent-fuel elements from power reactors, separate the reusable fissile material, and incorporate it into new fuel elements. Waste management facilities would also be provided for storage, conditioning, and disposal of radioactive wastes. The International Atomic Energy Agency has initiated a comprehensive study of the regional fuel cycle center concept, which is described in this paper.

286 Morphology of reprocessing: a case for regional utility planning. Stoller, S.M. (S. M. Stoller Corp., New York). pp 529-546 of In Nuclear power development and the fuel cycle. Farmakes, R. (ed.). Hinsdale, IL; American Nuclear Society, Inc. (1976).

From 1. Pacific Basin topical conference on nuclear development and the fuel cycle; Honolulu, Hawaii, United States of America (USA) (11 Oct 1976).

See CONF-761014—.

The change in entrepreneurial climate in reprocessing and recycle, which has taken place in the last few years, is reviewed. The climatic change, which has reached the point where the economic benefits of that fuel cycle segment are being questioned, is characterized. The author outlines the reasons he feels the benefits are positive. Some of the principal risks facing the entrepreneur are outlined and the suggestion is made that participation by the utility customers for a major project throughout its planning process is critical. In this context, the logic for a regional organization of such utilities, customers, drawing heavily from a study conducted by a group of utilities in the western United States during 1975, is outlined. The paper concludes with some general observations in support of the thesis that new structural forms are likely required for reprocessing facilities, as well as those for other major segments of the fuel cycle, if utilities are to be able to view with confidence the prospect of having such facilities in place in a timely fashion.

287 New situation has arisen in the fuel reprocessing field. Couture, J. (Compagnie Generale des Matieres Nucleaires, Chatillon, France). pp 547-563 of In Nuclear power development and the fuel cycle. Farmakes, R. (ed.). Hinsdale, IL; American Nuclear Society, Inc. (1976).

From 1. Pacific Basin topical conference on nuclear development and the fuel cycle; Honolulu, Hawaii, United States of America (USA) (11 Oct 1976).

See CONF-761014—.

Some factors that have led to the present world crisis in reprocessing are explained, and proposals to help solve the problem are given. The paper first deals with the historical and technical reasons for the expected "gap" in reprocessing many nations will face during the next decade; it is pointed out that, if necessary investments are not made now, the gap could increase. Uncertainties related to the reprocessing technology itself in addition to strong pressure of public opinion on safety requirements make investment evaluations difficult and imprecise. The ordinary contracts that were formerly in use and based on well-established reprocessing costs are no longer adaptable. A solution is proposed that consists of a "prepayment contract," which would allow the utilities to help the reprocessor finance part of the necessary investments. This kind of arrangement is one of the best ways, if not the only way to cut the reprocessing gap to the minimum, and will prevent the risk of reprocessing problems hindering the development of nuclear power production in several areas of the world.

288 Mexican projects on the back end of the fuel cycle. Kaufmann, F. (Instituto Nacional de Energia Nuclear Biblioteca, Mexico City). pp 565-572 of In Nuclear power development and the fuel cycle. Farmakes, R. (ed.). Hinsdale, IL; American Nuclear Society, Inc. (1976).

From 1. Pacific Basin topical conference on nuclear development and the fuel cycle; Honolulu, Hawaii, United States of America (USA) (11 Oct 1976).

See CONF-761014—.

The Mexican program to close the fuel cycle is described. This program is justified for safety, energy resource preservation, and economic reasons. The main objective of the present pilot-scale development work is the training of specialized technical staff needed for future construction and operation of production facilities with maximum national participation.

289 Present status and future program of nuclear fuel reprocessing in Japan. Tamiya, S. (Power Reactor and Nuclear Fuel Development Corp., Tokyo); Nakajima, K. pp 573-589 of In Nuclear power development and the fuel cycle. Farmakes, R. (ed.). Hinsdale, IL; American Nuclear Society, Inc. (1976).

From 1. Pacific Basin topical conference on nuclear development and the fuel cycle; Honolulu, Hawaii, United States of America (USA) (11 Oct 1976).

See CONF-761014—.

It is essential to resolve the reprocessing complex to develop a large nuclear power program. The measures currently being considered in Japan are (a) to bring the PNC reprocessing plant into routine operation as soon as possible, (b) to build a new reprocessing plant, probably associated with an interim storage pond, and (c) to contract with overseas reprocessors for reprocessing services. The history and current status of the PNC plant are described, followed by the plans for the new reprocessing plant.

290 Drying apparatus located back and front of a Voloxidizer for reprocessing of fast reactor fuels. Harada, K. (to Babcock Hitachi K.K., Tokyo (Japan)). Japanese Patent 1976-91,498/A/. 7 Feb 1975. 3p. (In Japanese).

Object: To permit a continuous spent fuel drying operation during a thermal oxidation process (voloxidation) effected between a shearing step and dissolution step in fuel retreatment. Structure: The invention comprises a gas-tight cylindrical outer barrel, a rotative shaft hermeticaily supported in the outer barrel, a cylindrical inner barrel having at least three chambers secured to the rotative shaft, a fuel inlet nozzle provided at a position corresponding to the top of the outer barrel and one of the chambers of the inner barrel, a fuel outlet nozzle provided at the bottom of the outer barrel and at the bottom of one of the other chambers of the inner barrel, and a drying gas inlet nozzle and an off-gas outlet nozzle provided at positions corresponding to the side wall of the outer barrel and the side wall of one the other chambers of the inner barrel. The spent fuel is continuously dried by intermittently rotating the inner barrel.

291 Significance of accidental excursions. Paxton, H.C. (Los Alamos Scientific Lab., NM). pp 93-108 of In Nuclear safety, 1975. Hetrick, D.L. (ed.). Hinsdale, IL; American Nuclear Society (1975).

From ANS topical meeting on nuclear safety; Tucson, Arizona, USA (5 Oct 1975).

See CONF-751044—.

All the criticality accidents in processing plants have occurred with solutions. The reasonably limited observed range of initial-spike yields is believed to be characteristic of practical solution-handling systems. With solids there is no similar nonexplosive limit, but experience supports the contention that there the probability of occurrence can be kept vanishingly small.

TRANSPORT AND STORAGE

REFER ALSO TO CITATION(S) 277, 330, 1261, 1262, 1264, 1266

292 Device for storing fissile material. Bevilacqua, F. (to Combustion Engineering, Inc., Windsor, Conn. (USA)). German(FRG) Patent 2,604,863/A/. 23 Sep 1976. 15p. (In German). 3 figs.

If fissile materials, e.g. nuclear reactor fuel elements are stored attention is to be paid that there is always enough distance so that no critical or supercritical mass will arise, even in case of an earthquake moving the store. It is therefore proposed to provide containers of neutron-absorbing material subdivided in such a way that the individual stored masses are separated from each other by a shielding wall. The containers for each mass are connected with each other by spacers, the distance corresponding to a minimum neutron stopping length. Stainless steel with a thickness of about 6.35 mm is mentioned as shielding material.

293 Spent-fuel transport: available as needed. Macklin, L. (TRANSNUCLEAR, Inc., White Plains, NY). pp 323-330 of In Nuclear power development and the fuel cycle. Farmakes, R. (ed.). Hinsdale, IL; American Nuclear Society, Inc. (1976).

From 1. Pacific Basin topical conference on nuclear development and the fuel cycle; Honolulu, Hawaii, United States of America (USA) (11 Oct 1976).

See CONF-761014—.

As a result of the general uncertainty as to when commercial reprocessing will actually take place in the United States (U.S.) and the long lead times now required before bringing a spent-fuel cask system in operation, it appears that serious problems can arise by 1979-1980 in cask capacity availability. Compounding the uncertainty with respect to cask capacity availability is the position taken by some of the U.S. railroad systems and some state and local governmental agencies in imposing restraints in the movement of spent fuel. By utility companies taking risk in committing to casks in advance of the actual requirement dates and by cask suppliers assuming the risks of licensing, costs, and delivery schedules, this potential bottleneck could be minimized.

294 Irradiated nuclear fuel transport from Japan to Europe. Kavanagh, M.T. (British Nuclear Fuels Ltd., Risley, Eng.); Shimoyama, S. pp 331-343 of In Nuclear power development and the fuel cycle. Farmakes, R. (ed.). Hinsdale, IL; American Nuclear Society, Inc. (1976).

From 1. Pacific Basin topical conference on nuclear development and the fuel cycle; Honolulu, Hawaii, United States of America (USA) (11 Oct 1976).

See CONF-761014—.

Irradiated nuclear fuel has been transported from Japan to Europe since 1969, although U.K. experience goes back almost two decades. Both magnox and oxide fuel have been transported, and the technical requirements associated with each type of fuel are outlined. The specialized ships used by British Nuclear Fuels Limited (BNFL) for this transport are described, as well as the ships being developed for future use in the Japan trade. The ship requirements are related to the regulatory position both in the United Kingdom and internationally, and the Japanese regulatory requirements are described. Finally, specific operational experience of a Japanese reactor operator is described.

295 Nuclear fuel on the move: to where. Brobst, W.A. pp 109-115 of In Nuclear safety, 1975. Hetrick, D.L. (ed.). Hinsdale, IL; American Nuclear Society (1975).

From ANS topical meeting on nuclear safety; Tucson, Arizona, USA (5 Oct 1975).

See CONF-751044—.

The political aspects of transportation safety of nuclear materials are discussed. The reluctance of railroads and aircraft to transport nuclear materials is pointed out. The need for the nuclear industry to join in the litigation to the ICC is emphasized. (DLC)

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 981, 982

296 Jahrbuch der Atomwirtschaft 1977. 8. Jahrgang. (Yearbook of the nuclear industry 1977. 8th annual volume). Mueller, W.D.; Hossner, R. (eds.). Duesseldorf, Germany, F.R.; Handelsblatt (1977). 314p. (In German).

With figs., tabs. and refs.

This year-book gives a comprehensive survey of the major events of the year 1976 in the field of nuclear power. Apart from current topics, the chapter 'perspectives' also contains papers on important issues. The facts (including addresses) relating to nuclear power make this year-book which has been published in this form and structure for many years - very useful as a book of reference.

297 Development and prospect of atomic industry. Tajima, T. (Industrial Bank of Japan Ltd., Tokyo). No. 9, 103-107(1976). (In Japanese).

From 9. annual conf. of the Japan Atomic Industrial Forum; Tokyo, Japan (10 Mar 1976).

Present status and main subjects of Japanese atomic industry are reviewed. The first subject is the technological potential of domestic plant makers. Reactor components for BWR and PWR are now being supplied by Hitachi, Toshiba, and Mitsubishi groups. More than 90% components are being manufactured by these three groups. Their ability of annual supply is estimated to be about 6000 MW. Standardization of plants and the improvement of productivity are being expected. The second subject is the establishment of the fuel cycle industries. Estimated needs of yellow cake are presented together with the recent movements of utilities and a group of mining companies. As for enrichment service, the necessity of international co-operation is suggested. The first domestic fuel reprocessing plant (200 tons/year) will go into operation in a couple of years. Yet a second plant will soon be required to meet the growing demand. It is emphasized that the delay in fuel cycle industries

should be recovered as soon as possible. The third subject concerns with the expected growth to an exporting industry. At present, only a small portion of components such as pressure vessel, fuel cladding pipes and turbines are being exported. The fourth subject is the source of capital. The projected demands of money and estimated shortage are discussed together with some counter measures.

298 Nuclear fuel resources of the Pacific Basin. Patterson, J.A. (Energy Research and Development Administration, Washington, DC). pp 145-170 of In Nuclear power development and the fuel cycle. Farmakes, R. (ed.). Hinsdale, IL; American Nuclear Society, Inc. (1976).

From 1. Pacific Basin topical conference on nuclear development and the fuel cycle; Honolulu, Hawaii, United States of America (USA) (11 Oct 1976).

See CONF-761014—.

Uranium will be the principal nuclear fuel for the rest of the century, although plutonium and some thorium will be used. Demands will grow rapidly, but uncertainties remain related to nuclear power growth, reprocessing, recycle, and enrichment services. Pacific Basin countries will have substantial growth in nuclear capacity and uranium demand and also a major role in world uranium supply. World and Pacific Basin uranium resources are largely in Precambrian shield areas and in sedimentary basins outside shield areas. The deposits, however, are quite variable in their geologic characteristics. In recent years additional types of deposits have been recognized. Substantial expansions to world production capability are projected. The levels attainable from known resources, however, may not be capable of meeting demands without recycle of uranium and plutonium and with high enrichment tails assays. Exploration over the past decade has kept pace with growing demands. Consideration of known world uranium resources and their geologic setting, in light of exploration effort, provides encouragement about prospects for identification of additional resources. Sound planning of national energy programs will need expanded efforts to assess world uranium resources.

299 Simulation of the plutonium economy using the NEEDS model. Willke, T.L.; Waddell, J.D.; Pardue, W.M. (Battelle Memorial Inst., Columbus, OH). pp 948-954 of In Modeling and simulation. Volume 7, Part 2. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P2.

Three different fuel cycle options for the nuclear power economy are compared to evaluate the benefits of using plutonium as a fuel for light-water reactors with or without the commercial introduction of the liquid metal fast breeder reactor (LMFBR) in the 1990's. The economic analysis is performed using a simulation of the U.S. nuclear power economy called NEEDS—an acronym for Nuclear Energy Electrical Demand Simulation. Over the 1975 to 2020 time period, plutonium recycle is shown to have economic advantages over other options with or without the breeder.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 879, 1386, 1387, 1388, 1389, 1390

300 (ORNL-tr—4433) **Status of management of radioactive wastes from nuclear power plants.** Sakata, S. Translated by H. Kubota from **54**: No. 577, 306-313(1975). 13p. Dep. NTIS, PC A02/MF A01.

The cognition for dealing with the radioactive waste has reached the waste management concept through the treatment and disposal from the simple disposal of the early stage. In nuclear-electric power generation system, many sorts of radioactive waste are generated from not only power stations but their related nuclear fuel cycle facilities. Two technical objectives in the waste treatment step are: the diminution of the release rate of radioactivity into the environment in fluid form, and the conditioning (solidification and packaging) of volume-reduced or concentrated wastes including both solid waste and wastes originated from the decommissioning of nuclear facilities. At this moment, endeavors dedicated for the diminution of release rate gives fairly good performances based on the "As Low As Practicable" principle, except the conditioning. Hereafter, much efforts will be concentrated on the following aspects, for example, diminution of the amount of the wastes to be solidified or packaged, realization of high volume reduction, and establishing the appropriate guidelines for packaging together with the consolidation of responsibility and financial liability.

WASTE PROCESSING

REFER ALSO TO CITATION(S) 285, 323, 1202, 1205

301 (MLM—2435) **Decontamination of HEPA filters: January—March 1977.** Luthy, D.F.; Lewis, E.L. 22 Jul 1977. Contract EY-76-C-04-0053. 17p. Dep. NTIS, PC A02/MF A01.

Various leaching agents were tested to determine their capability for dissolving PuO_2, UO_2, and U_3O_8. The amount of radionuclides retained by the filter media was investigated. Adsorption isotherms for two leaching systems were obtained. A four-stage dissolution process was developed. 10 figures, 2 tables.

302 Device for reducing the volume of slightly radioactive solid wastes. Gottwald, K. (to Kraftanlagen A.G., Heidelberg (Germany, F.R.)). German(FRG) Patent 2,543,256/A/. 31 Mar 1977. 8p. (In German).

1 fig.

The invention refers to a system with gates for uptake and discharge operating at low pressure. Slightly active solid wastes are put in, crushed by means of cutter blocks, and the comminuted material is finally put into a cask which is sealed. This device is characterized by an upper feeder section, by a size-reduction chamber in the middle, and by one or several lower solidification sections, the sections being right on top of each other, whereby the central axes of the various sections are staggered vertically and parallel to each other.

303 Reprocessing and treating radioactive waste. Laser, M. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Chemische Technologie). **26**: No. 5, 247-251(4 Mar 1977). (In German).

Describes processes of extracting uranium and plutonium from radioactive waste and the ways in which the waste products (radioactive I and Kr, tritium, fission product solutions, and the concentrates from the various purifying processes) are treated, (e.g. gas purification and fission product solidification). The risks associated with this processing are then discussed.

304 Contribution to the problem of solidification of medium and low radioactivity liquid wastes. Knieper, J.; Printz, H.; Woelfle, R. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Chemie). **30**: No. 1, 11-16(1977).

6 figs.; 6 tabs.; 8 refs.

The use of hitherto described methods for the solidification of medium and low radioactivity liquid wastes is associated with some drawbacks. Some of these can be eliminated in a newly developed procedure (patent pending) based on the reaction of gypsum with water. A series of tests were conducted on specimens containing fission nuclides to determine the release of volatile radionuclides to the air; leaching experiments in water and concentrated salt solutions were also performed. The leaching rates which are in the order of 10^{-2} cm/d can be lowered substantially (10^{-6}cm /d) by suitable additives or coatings. Besides, several significant advantages in comparison with other methods are shown. Finally, some aspects concerning the application of the method for subterranean long-term storage of radioactive waste solutions are discussed.

305 Method for solidifying liquid radioactive wastes. Berreth, J.R. (to Energy Research and Development Administration, Washington, D.C. (USA)). German(FRG) Patent 2,615,669/A/. 21 Oct 1976. 8p. (In German).

In order to simplify the processing of solutions containing radioactive substances, these are heated to reduce the volume. As long as these solutions contain nitrates or nitrites, nitrogen oxides are formed. According to the invention, one can prevent this if prior to heating urea is added to the solution (if possible the stoichiometric amount of urea corresponding to the nitrate or nitrite content) and this is heated to at least 180°C.

306 Method for processing radioactive concentrates. Queiser, H.; Meichsner, O. (to Licentia Patent-Verwaltungs-G.m.b.H., Frankfurt am Main (Germany, F.R.)). German(FRG) Patent 2,515,795/A/. 14 Oct 1976. 17p. (In German).

1 fig.

Waste solutions occuring in nuclear technology, containing radioactive materials, are concentrated in a known manner and these concentrates are solidified for end storage. A suggestion is made to carry out the solidification directly in the storage vessel using cement as binder. The latter should be put in a container (sack, capsule, bag) into the storage vessel and released there by chemical or mechanical destruction of the container.

307 Evaporator system, especially for radioactive liquids. Rushton, W.E. (to Whiting Corp., Harvey, Ill. (USA)). German(FRG) Patent 2,512,091/A/. 30 Sep 1976. 25p. (In German).

6 figs.

An evaporator system is proposed in which waste liquids from nuclear power plants containing radioactively contaminated solids are to be concentrated. The system with evaporating chamber, heat exchanger and cycling pump is described in great detail and 6 diagrams are given. All parts are easily accessible and the cycling

pump only needs to be periodically serviced at large time intervals as the scale formation is only very slight.

308 Method for processing solid wastes containing radioactive or toxic materials. Baehr, W.; Drobnik, S.H.; Hild, W.; Kroebel, R.; Meyer, A.; Naumann, G. (to Kernforschungszentrum Karlsruhe (Germany, F.R.)). German(FRG) Patent 2,363,475/B/. 23 Sep 1976. 5p. (In German).

A method is suggested for processing solid wastes, particularly from nuclear power plants, containing radioactive or toxic materials. According to the invention, they are displaced by a mixture of monovinyl and polyvinyl compounds, the appropriate catalysts and, where necessary, emulsifiers or swelling substances, and they are then polymerized irreversibly into solid blocks with good leaching and wasting resistance. Styrene or acryl methyl esters are used as monovinyl compounds, divinyl benzene or trivinyl benzene as polyvinyl compounds. 14 examples clarify the method.

309 Method to prepare essentially organic waste liquids containing radioactive or toxic materials. Baehr, W.; Drobnik, S.H.; Hild, W.; Kroebel, R.; Meyer, A.; Naumann, G. (to Kernforschungszentrum Karlsruhe (Germany, F.R.); Farbenfabriken Bayer A.G., Leverkusen (Germany, F.R.)). German(FRG) Patent 2,363,474/B/. 16 Sep 1976. 7p. (In German).

Waste solutions occuring in nuclear technology containing radioactive or toxic materials can be solidified by mixing with a polymerisable mixture with subsequent polymerization. An improvement of this method, especially for liquids in which the radioactive components are present as organic compounds is achieved by adding a mixture of at least one monomeric vinyl compound, at least one polyvinyl compound and appropriate catalysts and by polymerizing at temperatures between 15 and 150°C. Should the waste liquid contain mineral acid, this is first neutralized by the addition of CaO or MgO. In processing oils or soaps, the addition of swelling agent for polystyrol resins is advantageous. 16 examples illustrate the invention.

310 Method for processing radioactive washing water. Meichsner, O.; Queiser, H. (to Licentia Patent-Verwaltungs-G.m.b.H., Frankfurt am Main (Germany, F.R.)). German(FRG) Patent 2,219,485/C/. 16 Sep 1976. 4p. (In German).

1 fig.

An improvement of a method to process radioactively contaminated washing water from nuclear power plants is suggested in which energy and operating medium are saved. The invented method is a combination of ion exchange and filtration. Ion exchange resins are added to the contaminated washing water, the resulting resin-water suspension is put into a mechanical filter, filtered off, the filter cake containing all radioactive substances is dried and given to final storage. It is proposed to further reduce the cost by using waste resins not yet exhausted from the condensate purification of a BWR reactor.

311 Method for preparing liquid radioactive wastes from nuclear facilities for solidification. Schmieder, H.; Kroebel, R. (to Kernforschungszentrum Karlsruhe (Germany, F.R.)). German(FRG) Patent 2,449,588/A/. 22 Apr 1976. 12p. (In German).

In order to prepare aqueous waste solutions coming from reprocessing plants of spent fuel elements for final storage, an electrolysis is suggested having such current densities that the materials present in the solutions of the group hydrazine, hydroxyl amine, oxalic acid, oxalates, tartaric acid and tartrates are oxidized at the anode, and nitric acid, nitrates and nitrites are reduced at the cathode in a single working step. Platinum or platinized metals serve as anode material, titanium or graphite as cathode material. The apparative expenditure is small, in certain cases the fission products can be better fractionated after the electrolysis and the planned solidification in glass, ceramic, bitumen or cement is also easier to carry out.

312 Past, present and future outlook on the bituminization of radioactive wastes. History of the processing. Dejonghe, P. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). pp 9-25 of In Seminar on the bituminization of low and medium level radioactive wastes. Paris, France; OECD Nuclear Energy Agency (1976). (In French)

From Seminar on the bituminization of low and medium level radioactive wastes; Antwerp, Belgium (18 - 19 May 1976).

The history of the bituminization of radioactive wastes is briefly reviewed and some applications are presented. Schematic drawings of the equipment and flow sheets of the process are given.

313 Commissioning and start-up tests of Eurochemic's waste bituminization facility. Demonie, M. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). pp 56-76 of In Seminar on the bituminization of low and medium level radioactive wastes. Paris, France; OECD Nuclear Energy Agency (1976).

From Seminar on the bituminization of low and medium level radioactive wastes; Antwerp, Belgium (18 - 19 May 1976).

The commissioning tests of the Eurobitum Facility performed during the period October 1974 - December 1975 and the start-up experience gained during the period December 1975 - April 1976, are described.

314 Bituminization of radioactive waste solutions at Eurochemic. Eschrich, H. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). pp 26-55 of In Seminar on the bituminizatin of low and medium level radioactive wastes. Paris, France; OECD Nuclear Energy Agency (1976).

From Seminar on the bituminization of low and medium level radioactive wastes; Antwerp, Belgium (18 - 19 May 1976).

The Eurochemic Company has built a bituminization plant to solidify in the coming years the various medium-level waste solutions originating from the chemical decladding of nuclear fuels and other nuclear fuel reprocessing operations. Characteristic data on the liquid wastes to be solidified are given and the procedures and the main equipment used in the bituminization process are described. The lay-out of the bituminization plant is presented. Furthermore some results of studies, related to the realization of the medium-level waste bituminization project, are reported.

315 Bituminization of radioactive wastes at the Nuclear Research Center Karlsruhe - Experience from plant operation and development work. Hild, W.; Kluger, W.; Krause, H. (Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (Germany, F.R.)). pp 129-145 of In Seminar on the bituminization of low and medium level radioactive wastes. Paris, France; OECD Nuclear Energy Agency (1976).

From Seminar on the bituminization of low and medium level radioactive wastes; Antwerp, Belgium (18 - 19 May 1976).

A summary is given of the main operational experience gained at the Nuclear Research Center Karlsruhe in 4 years operation of the bituminization plant for evaporator concentrates from low- and medium level wastes. At the same time some of the essential results are compiled that have been obtained in the research and development activities on bituminization.

316 Review of the research and development work and experience in the field of bituminization in the member countries of the Council for Mutual Economic Assistance. Malasek, E. (Ceskoslovenska Komise pro Atomovou Energii, Prague); Kulichenko, V.V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow). pp 185-197 of In Seminar on the bituminizatin of low and medium level radioactive wastes. Paris, France; OECD Nuclear Energy Agency (1976).

From Seminar on the bituminization of low and medium level radioactive wastes; Antwerp, Belgium (18 - 19 May 1976).

This paper describes briefly the research and development work carried out in the member countries of the Council for Mutual Economic Assistance in connection with the development of the bituminization process for the solidification of radioactive wastes. Further on the operational techniques and developed equipment are described and the principles of safe disposal of bituminous products are summarized.

317 Review of the research and developmental work and experiences on the bituminization of radioactive wastes in Japan. Segawa, T. (Power Reactor and Nuclear Fuel Development Corp., Tokai, Ibaraki (Japan). Tokai Works); Kadoya, S. (Ebara Mfg. Co. Ltd., Tokyo (Japan)); Matsumoto, A. (Japan Atomic Energy Research Inst., Oarai, Ibaraki. Oarai Research Establishment). pp 158-184 of In Seminar on the bituminization of low and medium level radioactive wastes. Paris, France; OECD Nuclear Energy Agency (1976).

From Seminar on the bituminization of low and medium level radioactive wastes; Antwerp, Belgium (18 - 19 May 1976).

Efforts of development and improvement of the bituminization of radioactive wastes have been made by a few groups for the past ten and more years in Japan. A new approach to incorporation of radioactive sludges into emulsified asphalts by addition of a surfactant has been studied and the leachability of solidified products has been examined. Some developmental work of the bituminization of the evaporator concentrates expected from a reprocessing plant has been made and evaluation tests on the solidified products have been carried out. Incorporation into bitumen of the radioactive wastes arising at the JMTR has been practiced for three years.

318 Bituminization experience in Belgium. van de Voorde, N.; Peeters, K. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). pp 99-111 of In Seminar on the bituminization of low and medium level adioactive wastes. Paris, France; OECD Nuclear Energy Agency (1976). (In French)

From Seminar on the bituminization of low and medium level radioactive wastes; Antwerp, Belgium (18 - 19 May 1976).

The operational experience gained at Mol in 12 years operation of the bituminization process for concentrates from low level radioactive wastes is described. A pilot plant has been developed in

order to study the application of this process to the wastes from the sodium cooled reactors and the light water reactors.

319 Perspective of radioactive waste management in the Republic of China. Tsai, C.M. (Inst. of Nuclear Energy Research, Taiwan); Chu, B.P.H.; Weng, P.S. pp 503-514 of In Nuclear power development and the fuel cycle. Farmakes, R. (ed.). Hinsdale, IL; American Nuclear Society, Inc. (1976).

From 1. Pacific Basin topical conference on nuclear development and the fuel cycle; Honolulu, Hawaii, United States of America (USA) (11 Oct 1976).

See CONF-761014—.

A review of the management of low-, intermediate-, and high-level radioactive wastes, including an account of current practices, long-term plans, and need for international cooperation regarding their disposal is presented. Processes for the handling, storage, and ultimate disposal of solid wastes are discussed with reference to stressing technological aspects. Emphasis is placed on the safety criteria that the Government of Republic of China observes. Based on these criteria, some proposals for an international joint project in the Pacific Basin area are suggested.

320 New trends in the management of radioactive wastes in Japan. Ishihara, T. (Japan Atomic Energy Research Inst., Tokyo). pp 515-525 of In Nuclear power development and the fuel cycle. Farmakes, R. (ed.). Hinsdale, IL; American Nuclear Society, Inc. (1976).

From 1. Pacific Basin topical conference on nuclear development and the fuel cycle; Honolulu, Hawaii, United States of America (USA) (11 Oct 1976).

See CONF-761014—.

In the first two decades (1950's and 1960's) of Japan's nuclear history, the main radioactive wastes came from radioisotope utilization and were of low and intermediate level. A nationwide service network has been established to collect, process, and temporarily store these wastes in a Tokai repository. In the second stage (during the 1970's) nuclear power generation has grown to a level of 6000 MW(e) and is producing large quantities of low- and intermediate-level wastes. These wastes have been processed and temporarily stored at each station. To dispose of these in the sea and in the ground, a Nuclear Environment Conditioning Center is being established this year with economic support from electric power companies and related industries. It is planned to have new collaborative processing organizations in each field to handle the wastes from radioisotope utilization and nuclear fuel fabrication. A large quantity of high-level wastes is expected to be produced from reprocessing in the 1980's. Fundamental research and development work is going on and a national cooperative program has been discussed by specialists.

321 Physicochemical principles and calculation of processes used to evaporate highly active nitric acid solutions. Efimov, A.N.; Zhikharev, M.I.; Zhirnov, Yu.P. **39**: No. 6, 416-419(Dec 1975). (In Russian).

For English translation see the journal Sov. J. At. Energy.

To substantiate the most advantageous methods involved in the evaporation of high-active nitric acid solutions prior to their burying, study has been made of the liquid-vapor equilibrium in the systems type HNO_3-H_2O-Me(NO_3), where Me is Be, Cu, La, Ni, Al, Cr, Fe. A method of the distribution calculation for HNO_3 in these systems is proposed. The equilibrium has been explored by means of the circulation method on the modified Otmer appratus. The constitution of the equilibrium vapor as a function of pressure is given. The nitrates are shown to salt out HNO_3 into the vapor phase. The salting-out action of the nitrate mixture, expressed through a logarithm of the separation coefficient, is approximately additive. Consideration is given to an analytical-tabular method of the design of the evaporation process in vaporizers containing a rectifying tower.

WASTE DISPOSAL AND STORAGE

REFER ALSO TO CITATION(S) 319, 320, 342, 1994, 1995

322 (BNWL-SA—6158) **Waste isolation safety assessment program.** Dau, G.J. 1977. Contract EY-76-C-06-1830. 7p. (CONF-770221—2). Dep. NTIS, PC A02/MF A01.

From EPRI fuel cycle risk assessment workshop; Palo Alto, California, United States of America (USA) (9 Feb 1977).

Objective is to assess the safety of the long-term disposal of high-level radioactive waste in a geologic formation. The program is divided into five tasks: safety assessment concepts and methods, disruptive event analysis, source characterization, transport modeling, and nuclide transport data. Goals and planned work are listed for each task. (DLC)

323 (ERDA—1536) **Waste management operations, Idaho National Engineering Laboratory, Idaho. Final environmental impact statement.** Sep 1977. 731p. Dep. NTIS, PC A99/MF A01.

Chapters are provided on background; anticipated benefits; characterization of the INEL environment; environmental impact of operations; unavoidable adverse environmental effects; relationship between short-term uses and long-term productivity; relationship of waste management to land use, policies, and controls; irreversible and irretrievable commitments of resources; alternatives; and cost-benefit analysis. The five appendices are: References; Glossary of terms and abbreviations; Listing and disposition of past INEL releases; Calculational methods; and Summary of INEL waste statistics and improvements for 1975 and 1976 with projections of future wastes and projects. (LK)

324 (ERDA—1553) **Management of intermediate level radioactive waste, Oak Ridge National Laboratory, Oak Ridge, Tennessee. Final environmental impact statement.** Sep 1977. 322p. Dep. NTIS, PC A14/MF A01.

Chapters are devoted to the following topics: background and description; environmental impact of the proposed action; unavoidable adverse environmental effects; alternatives; relationship between short-term uses and long term productivity; state, local, or regional conflicts; irreversible and irretrievable commitments of resources; and cost benefit analysis. Four Appendices are provided: Glossary of terms; Characterization of existing environment; Calculations; Environmental monitoring of existing environment. (LK)

325 (LA-UR—77-1294) **Considerations for the long term: perpetual is not forever.** Wheeler, M.L.; Smith, W.J. 1977. Contract W-7405-ENG-36. 30p. (CONF-770512—18). Dep. NTIS, PC A04/MF A01.

From Symposium on management of low level radioactive waste; Atlanta, Georgia, United States of America (USA) (23 May 1977).

Shallow land burial is intended to provide a waste emplacement with low probability for the release of radionuclides to the environment, and to provide a barrier against encroachment on the waste by man or his activities. Additionally, the emplacement conditions are designed to insure that a potential release cannot result in unacceptable radionuclide concentrations in man's environment. Site-control requirements are intended to prevent unacceptable use or accidental excavation of the waste disposal site. Evaluation procedures generally provide definition of the containment capability of the site under present environmental conditions. Long-term care requirements can continue site control measures, and provide a continuing check on the containment capability. However, significant changes in climate, hydrology, plant cover, and land use that might alter the containment potential can occur in a time frame of tens to hundreds of years, and true "perpetual" care cannot be guaranteed. This paper considers the possible long-term consequences of radionuclide uptake by plants and burrowing animals, of changes in site hydrology, and of inadvertent excavation of the buried waste by man at some distant future date.

326 (ORNL/SUB—3706/7) **Analysis and evaluation of the rock mechanics aspects of the proposed salt-mine repository concept-III. Summary progress report RSI-0012.** Gnirk, P.F.; Callahan, G.D.; Pariseau, W.G.; Van Sambeek, L.L.; Wawersik, W.R. 28 Sep 1974. Contract W-7405-ENG-26;SUB-3706/7. 65p. Dep. NTIS, PC A04/MF A01.

Objective is to conduct a comprehensive analysis and evaluation of the rock mechanics aspects of the proposed salt-mine repository concept for the storage of radioactive wastes. Work was done in five areas: experimental quasi-static deformation of salt, experimental creep deformation of salt, transient heat conduction analysis, thermoelastic/plastic analysis of salt loading on waste container sleeve, and thermo/viscoelastic analysis of salt loading on the waste container sleeve. The transient temperature analysis included the room-and-pillar configuration for the Lyons, Kansas, concept, and the New Mexico pilot-plant concept. 26 figures, 10 tables. (DLC)

327 (ORNL/SUB—4269/1) **Thermoelastic/plastic analysis of waste-container sleeve. II. Influence of large displacements on sleeve loading. Technical memorandum report RSI-0017.** Pariseau, W.G. 31 Oct 1975. Contract W-7405-ENG-26. 18p. Dep. NTIS, PC A02/MF A01.

Modification of the thermoelastic/plastic finite element program to account for large displacements possibly associated with the development of an extensive plastic zone about a radioactive waste container emplaced in a typical repository room (SALT-4/T model) has been completed. Comparisons of radial stresses acting on the waste container and borehole wall displacements computed by the modified and conventional analyses techniques reveal little difference between the two sets of results over a 10 year heating period for salt strengths 25 percent of original values. Because no significant differences in results arise even under these exaggerated conditions, the more costly large displacement option need be used only sparingly as an occasional control check on the conventional procedure. As a consequence, economy of computer run time can be maintained without sacrifice of accuracy.

328 (ORNL/SUB—4269/5) **Thermo/viscoelastic analysis of the waste-container sleeve. II. Stress and displacement fields for the**

room-and-pillar configuration. Technical memorandum report RSI-0021. Callahan, G.D.; Ratigan, J.L. 31 Oct 1975. Contract W-7405-ENG-26-SUB-4269/5. 43p. Dep. NTIS, PC A03/MF A01.

Purpose of this report is to provide a composite presentation of and a future reference for the thermo/viscoelastic displacement and stress states in and about the pillar of a typical room-and-pillar configuration for the New Mexico (bedded salt) pilot-plant repository concept. The results were obtained through finite element analysis of the SALT-3A repository model. This model was developed in axially symmetric r-z geometry according to the room, pillar, waste container, and drillhole dimensions appropriate for the New Mexico pilot-plant concept. The model contains 317 nodes and 542 elements and represents a 202 ft vertical section through the room and pillar level. The floor level of the 18 ft x 18 ft room is located at a depth of 2,000 ft. The pillar width is 60 ft with the midpoint of the rib at the 1,991 ft level. 31 figures. (DLC)

329 (ORNL/SUB—4269/16) **Factor-of-safety formulations for linear and parabolic failure envelopes for rock. Technical memorandum report RSI-0038.** Gnirk, P.F. 21 Mar 1975. Contract W-7405-ENG-26;SUB-4269/16. 39p. Dep. NTIS, PC A03/MF A01.

This report presents documentation of the basic formulation of the factor-of-safety relationships for linear and parabolic failure criteria for rock with an example application for a candidate room-and-pillar configuration at the proposed Alpha repository site in New Mexico. 8 figures, 4 tables. (DLC)

330 (SAND—77-0369) **Neutron and gamma-ray sources in LWR high-level nuclear waste.** Dupree, S.A. Jun 1977. Contract EY-76-C-04-0789. 18p. Dep. NTIS, PC A02/MF A01.

Predictions of the composition of high-level waste from U-fueled LWRs have been used to calculate the neutron and gamma-ray sources in such waste at cooling times of 3 and 10 years. The results are intended for interim application to studies of waste shipping and storage pending the availability of more exact knowledge of fuel recycling and of waste concentration and solidification.

331 Disposal of radioactive wastes to the sea. Lewis, J.B. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). No. 14, 608-612(16 Jul 1977).

The subject is discussed under the following headings:-disposal routes; authorisations; environmental considerations, permissible radiation levels, radioactive background, critical paths; disposal of low level liquids, Windscale discharges, discharges from nuclear power stations, discharges from Winfrith and Dounreay; disposal of low level solid wastes, ocean capacity, operational procedure; possible use of the deep ocean for disposal of high level wastes. All the information is needed before any assessment can be made as to whether disposal routes would be satisfactory from the hazard point of view, let alone acceptable politically. It is concluded that no decision can be reached for many years, but it is pointed out that no decisions are needed for many years.

332 Development of National Waste Terminal Storage Program waste packaging criteria. LaRiviere, J.R.; Nelson, D.C.; Zweifel, H.A. (Atlantic Richfield Hanford Co., Richland, WA). **26**: 247-248(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

333 Waste management - nuclear style. McCall, P. **141**: No. 18, 245-246(30 Apr 1977).

Possible ways of disposing of highly radioactive wastes arising from the United Kingdom nuclear industry are briefly reviewed: projecting into outer space, dumping in containers in the ocean, or storage on land. The problems in each case and, in particular, the risks of environmental contamination from marine or land disposal, are discussed.

334 Physical radiation effects on salt rocks during high-level waste storage in salt formations. Kaschenz, H. (Ingenieurhochschule Zittau (German Democratic Republic). Sektion Kraftwerksanlagenbau und Energieumwandlung). **20**: No. 2, 35-38(Feb 1977). (In German).

Experimental results and methods of radiation effect measurements in alkali metal halides are reviewed. The types of crystal defects and, first of all, formation of such defects in ionic crystal lattices under irradiation are briefly explained. Recovery of radiation damages and its conditions are discussed in the light of experimental data. Special consideration is given to the release of the energy stored in the solid during irradiation. Possible hazards arising from this for the safe disposal of high-level wastes in salt formations are briefly discussed.

335 Storage of radioactive wastes in geological formations. Jaeckli, H. (Eidgenoessische Technische Hochschule, Zurich (Switzerland)). **68**: No. 1, 6-10(8 Jan 1977). (In German).

The results of eight years of systematic studies of possible geological formations in Switzerland are outlined. Applications for permission to explore five selected sites are under consideration.

336 Aims, organization and activities of the consortium for underground storage. Stucky, G. **68**: No. 1, 4-5(8 Jan 1977). (In German).

The consortium of Swiss authorities interested in underground storage (the petroleum oil and gas industries, for fuel storage; the nuclear industry for radioactive waste disposal), was initiated in 1972. The author outlines the motives behind the formation of the consortium and outlines its structure and objectives. The envisaged projects are outlined.

337 (ORNL-tr—4390) **Basic prerequisites and the practice of using deep water tables for burying liquid radioactive wastes.** Spitsyn, V.I.; Pimenov, M.K.; Balukova, V.D.; Leontichuk, A.S.; Kokorin, I.N.; Yudin, F.P.; Rakov, N.A. 1977. Translation by S.D. Blalock Jr. of CN—36/345. (CONF-770505—233). 19p. Dep. NTIS, PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

In the USSR, creating reservoirs for liquid radioactive wastes is one of the promising methods of safely disposing of them in deep water tables, in zones with a standing regime or a slow rate of subterranean water exchange. The results of investigations and the practice of burying (the wastes) indicate the reliability and effectiveness of such a method of final waste disposal when the basic requirements of environmental protection are observed. Geological formations and collector strata that guarantee the localization of the liquid radioactive wastes placed in them for many tens and even hundreds of thousands of years can be studied and chosen in different regions. The basic requirements and criteria to which the geological structures and collector strata must correspond for ensuring the safe burial of wastes have been formulated. Wastes are buried only after a comprehensive, scientifically based evaluation of the sanitary-radiation safety for this generation and future ones, taking into account the burial regime and the physico-chemical processes that accompany combining wastes with rocks and stratal waters, as well as the time of holding wastes to maximum permissible concentrations. Positive and negative factors that characterize the method are analyzed. Possible emergency situations with subterranean burial are evaluated. The composition and methods of the geological survey, hydrodynamic, geophysical, physico-chemical and sanitary-radiation investigations; methods of calculating and predicting the movement of wastes underground;methods of preparing wastes for burial and chemical methods of restoring the suitability of wells; design characteristics and conditions of preparing wells for use; methods of estimating heating and processes of radiolysis for a medium containing highly radioactive wastes; methods of operational and remote control of the burial process and the condition of the ambient medium, etc. are briefly examined.

338 Method and arrangement for the disposal of radioactive wastes from nuclear power plants. Baatz, H. (to STEAG Kernenergie G.m.b.H., Essen (Germany, F.R.)). German(FRG) Patent 2,511,957/A/. 7 Oct 1976. 13p. (In German).
1 fig.

A proposal is made that radioactive wastes should be directly filled into deposit containers in the nuclear power plant and solidified, and then be immediately led to final storage site. The equipment necessary for this consists of numerous deposit containers with a deaerating system and a device for injecting a solidification medium, an injection system and a waste air purifier. A transportable shielding device prevents the escape of radiation where necessary. Details of the equipment such as the connections of the injection and waste air pipes etc. are described.

339 Volatilization of low temperature borosilicate glasses for high-level radioactive wastes at elevated temperatures. Terai, R.; Kosaka, E. (Kinki Univ., Higashi-Osaka, Osaka (Japan). Faculty of Science and Technology). **27**: No. 3, 150-156(Sep 1976). (In Japanese).

Vaporization of low temperature borosilicate glasses suitable for storage of high-level radioactive wastes was investigated thermogravimetrically over the temperature range from 1300 to 900°C. Vaporization processes of many glasses used were apparently zero-order reaction at any temperature, suggesting that the controlling-step was the simple escape of volatile components from surface of the melts. It was determined by the chemical analysis that preferential volatile constituents were alkali-borates, such as $Na_2O.B_2O_3$ for Na_2O containing glasses, $2K_2O.B_2O_3$ for K_2O containing glasses at a lower temperature and $K_2O.B_2O_3$ at higher temperatures. Apparent activation energy calculated from Arrhenius-type plotting of evaporation rate was about 50 -- 60 kcal/mole, being similar to the evaporation heat of alkali-borates. However, vaporization of some glasses gave parabolic curves at high temperatures, which were attributed to the overlap of both processes of evaporation from surface of the melts and diffusion of volatile

components within the melts. It must pay much attention from viewpoint of safety evaluation that low temperature borosilicate glasses have a large evaporation rate at high temperature, that the vapor exerts a severe corrosivity upon the apparatus materials, and that the evaporation rate of borosilicate glasses was considerably enhanced by the water vapor in atmosphere. Safety temperature at which the escape ratio of volatile components should be depressed up to the order of 10^{-6} [g/cm^2.day] was estimated at about 600 -- 700°C for these glasses.

340 Storage facility for solid medium level waste at Eurochemic. Balseyro-Castro, M. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). pp 77-96 of In Seminar on the bituminization of low and medium radioactive wastes. Paris, France; OECD Nuclear Energy Agency (1976).

From Seminar on the bituminization of low and medium level radioactive wastes; Antwerp, Belgium (18 - 19 May 1976).

An engineered surface storage facility is described; it will serve for the interim storage of solid and solidified medium-level waste resulting from the reprocessing of irradiated fuels. Up till now, two storage bunkers have been constructed. Each of them is 64 m long, 12 m wide and 8 m high and can take up to about 5,000 drums of 220 l volume. The drums are stored in a vertical position and in four layers. The waste product drums are transported by a wagon to the entrance of the bunkers from where they are transferred in to the bunker by an overhead crane which is remotely controlled by high-frequency modulated laser beams. A closed-circuit camera is used to watch the handling operations. The waste stored is fully retrievable, either by means of an overhead crane of a lift-truck and can then be transported to an ultimate storage site.

341 Radiolysis and temperature effects in case of undeground storage of bitumen. Smailos, E.; Diefenbacher, W.; Korthaus, E.; Comper, W. (Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (Germany, F.R.)). pp 146-157 of In Seminar on the bituminization of low and medium level radioactive wastes. Paris, France; OECD Nuclear Energy Agency (1976).

From Seminar on the bituminization of low and medium level radioactive wastes; Antwerp, Belgium (18 - 19 May 1976).

On conservative assumptions limit values were determined for the specific activity in the bitumen products, which safely avoid under the conditions of storage in a non-ventilated prototype cavity both the formation of an ignitable radiolytic gas/air mixture and intolerable heating of wastes products over the entire storage time. Depending on the filling factor of the cavity and on the age of fixed fission products, the limit values of the specific activity in the waste products allowing to avoid an ignitable gas/air mixture in the cavity range from 0.09 Ci/l to 0.78 Ci/l. The respective limit values of specific activity allowing to avoid intolerable heating of wastes (> 70°C) range from 0.3 Ci/l to 0.7 Ci/l, depending on the age of fission products and on the type of storage.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 239, 281, 323, 324

342 (ORP/CSD—77-1) **Proceedings: a workshop on issue pertinent to the development of environmental protection criteria for radioactive wastes.** 1977. 221p. (CONF-770218—). Protection Agency, Office of Radiation Programs, Washington, DC.

From EPA workshop on environmental criteria development for radioactive waste management; Reston, Virginia, United States of America (USA) (3 Feb 1977).

The results are presented from three working groups on approaches to radioactive waste management criteria development, risk considerations of radioactive waste management, and long-term implications of radioactive waste management. (LK)

343 Ranger uranium environmental inquiry. Second report. Fox, R.W.; Kelleher, G.G.; Kerr, C.B. Canberra, Australia; Aust. Govt. Publ. Serv. (1977). 415p.

This is the second report of the Ranger Uranium Environmental Inquiry, the terms of reference of the Inquiry being set out in the first report. The Commission inquired into all the environmental aspects of: (a) the formulation of proposals, (b) the carrying out of works and other projects, (c) the negotiation, operation and enforcement of agreements and arrangements, (d) the making of, or the participation in the making of, decisions and recommendations, and (e) the incurring of expenditure, relating to the development of uranium deposits in the Northern Territory of Australia.

344 Environmental aspects of recycle fuels. Cupo, J.V. (Westinghouse Electric Corp., Pittsburgh). pp 389-408 of In Nuclear power development and the fuel cycle. Farmakes, R. (ed.). Hinsdale, IL; American Nuclear Society, Inc. (1976).

From 1. Pacific Basin topical conference on nuclear development and the fuel cycle; Honolulu, Hawaii, United States of America (USA) (11 Oct 1976).

See CONF-761014—.

Significant decreased environmental impacts due to plutonium recycle in 1990 are summarized. Operating data from the Westinghouse Plutonium Fuel Development Laboratory in Cheswick, Pennsylvania, are given. (LK)

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 281, 291, 857, 879, 880, 881, 1473

345 (PB—266831) **Known volume air sampling pump. Final summary report Jun 1975—Nov 1976.** McCullough, J.E.; Peterson, A. Nov 1976. Contract H0252017. 38p. NTIS PC A03/MF A01.

The purpose of this development program was to design and develop a known volume air sampling pump for use in measuring the amount of radioactive material in the atmosphere of an underground uranium mine. The principal nuclear radiation hazard to underground uranium mines comes from the mine atmosphere. Daughter products of radon-222 are inhaled by the miner resulting in a relatively high lung cancer rate among these workers. Current exposure control practice employs spot sampling in working areas to measure working level values. Currently available personal air sampling pumps fail to deliver known volumes of air under widely changing differential pressures. A unique type of gas pump known as the scroll compressor, developed by Arthur D. Little, Inc., that has no values and few moving parts is expected to provide a practical, efficient, and dependable air pump for use in dosimeters. The three deliverable known volume air sampling pumps resulting from this work incorporate a scroll pump, drive motor, speed control electronics, and battery pack in a container suitable for attachment to a miner's belt.

346 Nukleare Sicherheit bei Wiederaufarbeitungsanlagen. (Nuclear safety in fuel-reprocessing plants). Hennies, H.H.; Koerting, K. (Kernforschungszentrum Karlsruhe (Germany, F.R.)). Bonn, Germany, F.R.; DAtF (1976). 17p. (In German).

From 4. annual colloquium of the Projekt Nukleare Sicherheit; Karlsruhe, Germany, F.R. (23 Nov 1976).

6 figs.; 10 refs.

The danger potential of nuclear power and fuel reprocessing plants in normal operation is compared. It becomes obvious that there are no basic differences. The analysis of possible accidents - blow-up of an evaporator for highly active wastes, zircaloy burning, cooling failure in self-heating process solutions, burning of a charged solvent, criticality accidents - shows that they are kept under control by the plant layout.

REGULATIONS

REFER ALSO TO CITATION(S) 1008

ACCOUNTABILITY AND SAFEGUARDS

REFER ALSO TO CITATION(S) 981

347 (CONF-770656—2) **Optimal state estimation theory applied to safeguards accounting.** Pike, D.H.; Morrison, G.W. 1977. Contract W-7405-ENG-26. 19p. Dep. NTIS, PC A02/MF A01.

From Annual meeting of the Institute of Nuclear Materials Management; Washington, District of Columbia, United States of America (USA) (29 Jun 1977).

This paper presents a unified theory for the application of modern state estimation techniques to nuclear material accountability. First a summary of the current MUF/LEMUF approach is detailed. It is shown that when inventory measurement error is large in comparison to transfer measurement error, improved estimates of the losses can be achieved using the cumulative summation technique. However, the optimal estimator is shown to be the Kalman filter. An enhancement of the retrospective estimation of losses can be achieved using linear smoothing. State space models are developed for a mixed oxide fuel fabrication facility and examples are presented.

348 (SAND—77-0054) **Small-scale engagement model with arrivals: analytical solutions.** Engi, D. Apr 1977. Contract EY-76-C-04-0789. 24p. (NUREG—0238). Dep. NTIS, PC A02/MF A01.

This report presents an analytical model of small-scale battles. The specific impetus for this effort was provided by a need to characterize hypothetical battles between guards at a nuclear facility and their potential adversaries. The solution procedure can be used to find measures of a number of critical parameters; for example, the

win probabilities and the expected duration of the battle. Numerical solutions are obtainable if the total number of individual combatants on the opposing sides is less than 10. For smaller force size battles, with one or two combatants on each side, symbolic solutions can be found. The symbolic solutions express the output parameters abstractly in terms of symbolic representations of the input parameters while the numerical solutions are expressed as numerical values. The input parameters are derived from the probability distributions of the attrition and arrival processes. The solution procedure reduces to solving sets of linear equations that have been constructed from the input parameters. The approach presented in this report does not address the problems associated with measuring the inputs. Rather, this report attempts to establish a relatively simple structure within which small-scale battles can be studied.

349 (SAND—77-0502C) **Electric field sensor studies.** Griffith, R.D.; Parks, S. 1977. Contract EY-76-C-04-0789. 15p. (CONF-770716—1). Dep. NTIS, PC A02/MF A01.

From Meeting on sensor technology for battlefield and physical security applications; Fort Belvoir, Virginia, United States of America (USA) (13 Jul 1977).

Above-ground intrusion sensors are reviewed briefly. Buried wire sensors are next considered; feasibility studies were conducted. A triangular system of an overhead transmitter wire exciting two buried sensor wires was developed and tested. It failed sometimes to detect a man making a broad jump. A differential receiver was developed to solve this problem. (DLC)

350 (SAND—77-8624) **Conflict simulation for surface transport systems.** Keeton, S.C.; De Laquil, P. III. Jul 1977. Contract EY-76-C-04-0789. 17p. (CONF-770656—23). Dep. NTIS, PC A02/MF A01.

From Annual meeting of the Institute of Nuclear Materials Management; Washington, District of Columbia, United States of America (USA) (29 Jun 1977).

An important element in the analysis of transportation safeguards systems is the determination of the outcome of an armed attack against the system. Such information is necessary to understand relationships among the various defender tactics, weapons systems, and adversary attributes. A battle model, SABRES, which can simulate safeguards engagements is under development. This paper briefly describes the first phase of SABRES and presents some examples of its capabilities.

351 **Non-destructive methods of measurement for instrumental safeguards.** Boehnel, K.; Kuechle, M. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik); Ottmar, H. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Angewandte Kernphysik). **8**: No. 2, . 6-11(1976). (In German).

9 figs.

The instrumental safeguards system is aimed at continuous or discontinuous monitorig of the materials flow at predetermined points (key measuring points) by means of quantitative measurement. In addition complete inventories are to be taken at certain intervals - again with the aid of quantitative measurements. The data received on them are then compared with the book inventory given by the operator. With large deviations, the suspicion of branching off fissile material from the field of peaceful use will arise.

352 **Industrial production and working up of plutonium.** Lafontaine, I. (Societe Belge pour l'Industrie Nucleaire, Brussels). **1**: No. 1, 9-42(1976). (In French).

The aim of this paper is to deal with the evaluation of plutonium amounts which will be produced by nuclear power plants up to 1980 and those plants currently capable of treating nuclear fuels used to recover the plutonium. As soon as plutonium, as the dioxide, is available it is transported to fuel elements fabrication plants in containers specially approved by the responsible authorities and having to comply with very strict tests imposed by the IAEA. Additional protection is assured during transport, particularly in the event of a diversion attempt on nuclear materials. The nuclear fabrication plant is designed on the basis of thorough security. Indeed, various accident probabilities and their relative hazards have been evaluated and have led particularly to safe working norms as well as to the setting up of protective devices.

353 **Safeguards in Pu treating factories.** van der Stricht, E. (Commission of the European Communities, Luxembourg). **1**: No. 1, 55-69(1976). (In French).

The legal basis of the Euratom Safeguards system as well as a brief description of the provisions of the Treaty of Rome and the Treaty of Non Proliferation are given. Some practical aspects of the way in which these provisions are applied to factories treating Pu are illustrated by examples. In particular, the material balance and its uncertainty are disucssed. The importance of inventory taking as a major part of this uncertainty is demonstrated and the difficulties associated with the stock take and verification both for the operator and the inspector are shown.

354 **Safeguards: industry perspectives.** Gray, J.E.; Alikonis, N. (International Energy Associates Ltd., Washington, DC). pp 275-284 of In Nuclear power development and the fuel cycle. Farmakes, R. (ed.). Hinsdale, IL; American Nuclear Society, Inc. (1976).

From 1. Pacific Basin topical conference on nuclear development and the fuel cycle; Honolulu, Hawaii, United States of America (USA) (11 Oct 1976).

See CONF-761014—.

Safeguards are measures taken to prevent malicious use of materials, technology, and facilities associated with nuclear electric power generation. Safeguards development has been and will continue to be influenced by a number of groups, including the utilities, suppliers, the U.S. government, foreign nations, potentially malevolent groups, and the general public. Unresolved issues associated with the safeguards problem include utilization of reprocessing and plutonium recycle and the safeguards they would require, concern about nuclear exports, methods of judging safeguards adequacy, the respective roles of government and industry, civil liberties implications, and the possibilities for international cooperation. Safeguards uncertainty has affected industry in its projections of future costs and facilities planning. Future decisions regarding safeguards require the attention of both government and industry.

355 **Safeguards for the peaceful nuclear fuel cycle.** Kawashima, Y. (Nuclear Material Control Center, Tokyo). pp 307-321 of In Nuclear power development and the fuel cycle. Farmakes, R. (ed.). Hinsdale, IL; American Nuclear Society, Inc. (1976).

From 1. Pacific Basin topical conference on nuclear development and the fuel cycle; Honolulu, Hawaii, United States of America (USA) (11 Oct 1976).

See CONF-761014—.

To explore future prospects of safeguards, the historical development of safeguards is analyzed, which indicates extension of the safeguards system to a global scale. Study of the technical structure of the latest safeguards system clarified the success of IAEA in transforming political aim into technical objective, and the difficulties the present safeguards system will have to overcome. Recent changes in the safeguards environment point out the necessity to reconsider the framework of safeguards. Based on these observations, development of the peaceful nuclear fuel cycle is proposed as a tangible target for a new safeguards system. Particularly important is to distinguish bilateral or multilateral agreements, which form the basis of safeguards, from administration of safeguards. As safeguards are to prove that the commitments under the international agreements are observed, the administration of safeguards should be carried out to increase mutual confidence of the states. Development of a peaceful nuclear fuel cycle, supported by effective safeguards, will stimulate and facilitate international cooperation in key problems in the nuclear fuel cycle. The term "safeguards" was initiated in 1946 by the Atomic Energy Commission of the United Nations. By tracing the developments of safeguards over these 30 years, this paper explores their future prospects.

356 **Safeguards and regional planning.** Velez, C. (Instituto de Investigaciones Electricas, Palmira, Mexico). pp 417-421 of In Nuclear power development and the fuel cycle. Farmakes, R. (ed.). Hinsdale, IL; American Nuclear Soccicty, Inc. (1976).

From 1. Pacific Basin topical conference on nuclear development and the fuel cycle; Honolulu, Hawaii, United States of America (USA) (11 Oct 1976).

See CONF-761014—.

A brief statement is given on safeguards and regional planning, emphasizing the need for safeguards. An appendix contains parts from a recently proposed draft agreement on safeguards. (LK)

357 **International fuel cycle: accountancy for safeguards.** Rometsch, R. pp 116-126 of In Nuclear safety, 1975. Hetrick, D.L. (ed.). Hinsdale, IL; American Nuclear Society (1975).

From ANS topical meeting on nuclear safety; Tucson, Arizona, USA (5 Oct 1975).

See CONF-751044—.

After the spread of nuclear power in the 1960s, the Non-Proliferation Treaty (NPT) was developed in 1970 to limit the spread of nuclear weapons. The safeguards agreements inside and outside the NPT framework are compared. The backbone of NPT safeguards is nuclear material accountancy. Although good progress has been made in putting the NPT into effect, only 20% of the nuclear material connected with the 94,000 MW(e) power capacity is today subject to IAEA safeguards, with about half being outside NPT, but the non-NPT agreements are becoming more and more rigid. Sanctions which can be applied in case of noncompliance are described. The importance of Article VI of NPT (nuclear disarmament) is emphasized. (DLC)

358 **Plutonium: some political and social considerations.** Sagan, L.A. (Palo Alto Medical Clinic, CA). pp 16-20 of In Nuclear safety, 1975. Hetrick, D.L. (ed.). Hinsdale, IL; American Nuclear Society (1975).

From ANS topical meeting on nuclear safety; Tucson, Arizona, USA (5 Oct 1975).
See CONF-751044—.

In the next ten to 15 years there will be a worldwide increase of some three to four-fold in the number of nuclear reactors available for electrical generation. Many more nations will be going nuclear for the first time. The Swedish Research Institute reports that sometime in the early 1980's there will be each year between 7,000 and 12,000 shipments of nuclear materials between reactors and reprocessing plants. Such rapid development of the nuclear industry creates certain safety problems of which the public is well aware. Indeed, in view of the excellent safety record of reactor operation, the level of public concern may be exaggerated. On the other hand, there is a serious problem related to the nuclear fuel cycle that has not yet engaged the attention either of the public or of the nuclear community. This is the purposeful release engendered by terrorists or governments through the use of nuclear weapons. Political and social aspects of this problem are discussed.

PROCESSING

REFER ALSO TO CITATION(S) 1997

REGULATIONS

REFER ALSO TO CITATION(S) 1008

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

PHYSICAL ISOTOPE SEPARATION

359 Separation of xenon isotopes in an rf gas discharge. Karchevskii, A.I.; Martsynk'yan, V.L.; Popov, I.A.; Potanin, E.P. (I. V. Kurchatov Institute of Atomic Energy, Moscow). **3**: No. 2, 233-237(Mar 1977).

The separation of Xe isotopes in an rf discharge with a traveling magnetic wave is studied. An enrichment of ~6% in a quasibinary mixture of Xe^{136} and Xe^{129} is attained in a cylindrical water-cooled chamber 1 m long and 0.1 m in diameter at working pressures of $\sim 10^{-2}$—10^{-1} torr and at an rf power level of ~5 kW applied to the plasma. Over the pressure range studied, the observed separation is due primarily to thermodiffusion, which is itself due to the radial temperature gradient.

RADIATION SOURCES

OTHER INDUSTRIAL USES

360 Radioactive lightning conductor with ionized-gas current. Donelli, B.L. US Patent 4,039,739. 2 Aug 1977. Priority date 13 Sep 1974, Italy. 4p.

The invention relates to a radioactive lightning conductor comprising, associated to the metal lightning rod, an insulator body acting as support for a source of radioactive emissions, the source being contained inside a container, which forms a chamber sealed against the direct outlet of radioactive emission, but which has openings of connection with the outward air. The chamber of the container is further connected to a gas source, apt to produce a gas flow from the inside to the outside of the container, through the openings.

ISOTOPIC POWER SUPPLIES

DESIGN AND FABRICATION

361 (DPST—77-128-8) **Savannah River Laboratory monthly report: ^{238}Pu fuel form processes.** Aug 1977. Contract EY-76-C-09-0001. 14p. Dep. NTIS, PC A02/MF A01.

Goals of the Savannah River Laboratory (SRL) program are: to provide technical support for the transfer of DNRA ^{238}Pu fuel form fabrication operations from Mound Laboratory to new facilities being built at the Savannah River Plant (SRP), to provide the technical basis for ^{238}Pu scrap recovery at SRP, and to assist in sustaining plant operations. Microstructural damage from agglomeration of alpha decay helium was not observed in MHW pellets aged for 26 months until they were heated above 1200°C. Preheating specimens below this threshold, to release decay helium without causing microstructural damage, did not prevent grain separations during subsequent heating above the threshold temperature. Completion of checkout of major equipment and systems has been delayed to mid-September because of equipment malfunction and delays in delivery of vital components. Hot startup has been rescheduled for November 1977. Processing of offsite scrap continued. Charges to the dissolvers totalled 848.0 g of ^{238}Pu. One scrap shipment of 2802.7 of 80% ^{238}Pu was received from LASL during the month. The inventory of 80% of ^{238}Pu offsite scrap totals 5987.5 g and includes 4749.6 g from LASL, 1009.6 g from Mound Laboratory, and 228.3 g from miscellaneous sources. The medical-grade scrap inventory consists of 208.2 g of 90% ^{238}Pu and 642.8 g of 80 to 86% ^{238}Pu.

HYDROGEN

362 (NTISUB/A/023—77-002) **Quarterly literature review of hydrogen energy. A bibliography with abstracts. Quarterly update, April—June 1977.** 1977. 12p. (TAC-H—77-002). NTIS.

Abstracts of 16 current articles on hydrogen are presented (LK)

PRODUCTION

363 Cracking-tube furnace for the production of hydrogen. Baumgaertner, H. (to Hochtemperatur-Reaktorbau G.m.b.H., Koeln (Germany, F.R.)). German(FRG) Patent 2,515,821/A/. 21 Oct 1976. 15p. (In German).

3 figs.

The invention concerns the improvement of the arrangement of the cracking tubes in a cracking-tube furnace for production of hydrogen with the aid of thermal energy released by a gas-cooled high-temperature nuclear reactor. In order to avoid radial deviation of the cracking tubes, it is proposed to fix them with their lower end in bores of a plate closing the furnace space, where care has been taken that no additional problems, caused by thermal expansion, can occur.

ELECTROLYSIS

364 Economic aspects. Pottier, J. (Gaz de Fr). **89**: No. 4, 269-283(Oct-Nov 1976). (In French).

This report on economic prospects for hydrogen compares first performances and costs of various processes for hydrogen production, taking in account necessary delays for industrial development of new techniques. The medium term prospects are thus analyzed: they are based on the development of pipeline networks for transport and distribution of hydrogen, and on the production by new techniques such as off-peak electrolysis and nuclear methane reforming for larger industrial use of hydrogen. The long term role of hydrogen, as an energetic vector produced from nuclear energy, is then discussed.

365 Hydrogen: actual means of production and future prospects based on nuclear energy. Bernert, H. (Inst fuer Reaktorenwicklung, Kernforschungsanlage, Ger). **89**: No. 4, 260-268(1976).

Conversion of nuclear energy into a readily usable energy carrier by producing hydrogen from water is considered. The actual means of production of hydrogen as a chemical raw material are briefly described, viz.: steam reforming of natural gas, steam reforming of light hydrocarbons (naphtha), partial oxidation of heavy oils (residual oils) and gasification of coal. The long term options of primary energy sources for a country like the Federal Republic of Germany are indicated as follows: coal (at a fraction of 10-15%), non-nuclear and non-fossil energy at 10-15%), nuclear energy (70-80%). Processes for the production of hydrogen from nuclear energy--electrolysis, nuclear coal gasification and nuclear water splitting--are explained. 22 refs.

THERMOCHEMICAL PROCESSES

REFER ALSO TO CITATION(S) 364, 365

366 (LA-tr—77-52) **Production method for hydrogen by thermochemical decomposition of water.** Takashi, H. 1977. Translation of Japanese Patent Disclosure No. 51-9093. 18p. Dep. NTIS, PC A02/MF A01.

A method of producing hydrogen by thermochemical decomposition of water is claimed and has the following characteristics: Triiron tetroxide and hydrogen are generated by thermal decomposition of ferrous hydroxide or from the reaction of water and ferrous oxide. The generated triiron tetroxide is caused to react with hydrogen halide or ammonium halide to obtain ferrous halide and halogen gas as well as ammonia gas. In cases when ferric halide is generated

as a by-product, it is thermally decomposed to become ferrous halide and halogen gas. The ferrous halide is caused to react with alkali to obtain ferrous hydroxide or ferrous oxide as well as halide of alkali or the substance decomposed from this. The halogen gas is caused to react with either metallic oxide, with carbonate or with nitrate to generate oxygen. Alkali is regenerated from the reaction by-products by well known methods.

367 Thermochemical processes for water decomposition: prospects of a new hydrogen production method with nuclear heat. Beghi, G.; de Beni, G. (European Economic Community, Ispra, Italy). **12**: No. 3/4, 56-64(1976). (In Italian).

A discussion covers thermodynamic considerations for water decomposition; nuclear reactor types possible as heat sources; thermochemical cycles for water decomposition; the technology of integrated nuclear reactor/thermochemical water dissociation plants; and technical and cost estimates.

368 Multistage thermal decomposition process and radiation decomposition process of water. pp 163-235 of In Latest literature on hydrogen technology. Tokyo, Japan; ISU (1975). (In Japanese)

The principle and development of the processes for producing hydrogen from water by using nuclear fission energy, particularly those of the multistage decomposition process using nuclear heat and the radiation decomposition process using radiation energy, are described. This report is divided into five parts, namely 1) the principle of thermochemical decomposition of water, (2) the thermodynamical functions for the substances related to the multistage thermochemical decomposition process, (3) the constitution of the multistage thermochemical decomposition process, (4) the reaction cycle and thermodynamical study of the multistage thermochemical decomposition process, and (5) the radiation decomposition process. The multistage thermochemical decomposition process is very interesting scientifically, but it has many problems to be solved to establish a new hydrogen production system. These problems are: (1) the thermal efficiency which is not always high, (2) the reaction of different phases, (3) too many stages of reaction, and (4) too much amount of material circulation. The important problem of the radiation decomposition process is the effort to improve the efficiency of energy. The decomposition of water and carbon dioxide are reviewed.

STEAM REFORMER PROCESSES

369 Process device for carrying out endothermic high-temperature reactions. Coast, G.; Briody, R.F. (to UKAEA London Office). German(FRG) Patent 2,621,313/A/. 25 Nov 1976. 9p. (In German). 2 figs.

With the devices for carrying out endothermic reactions with the aid of hot gas supplied by a high-temperature reactor, there will arise diffculties in distributing the large amounts of heat uniformly over the reaction zones. It is now proposed to install heating gas pipes in the borings of the walls of the reaction pipes containing the catalyst. The supply of heating gas is provided by means of plastic connecting pieces. The invention is described by the example of a reforming process of methane and steam in order to obtain hydrogen.

BIOSYNTHESIS

REFER ALSO TO CITATION(S) 462

COAL GASIFICATION

REFER ALSO TO CITATION(S) 364, 365

370 (FE—2206-7) Catalytic conversion of coal energy to hydrogen. Semiannual report, June 1—December 31, 1976. Starkovich, J.A.; Pinkerton, J.D.; Murray, C.F. Jan 1977. Contract EX-76-C-01-2206. 91p. Dep. NTIS, PC A05/MF A01.

This project is concerned with an experimental investigation of the properties of alkali and alkaline earth metal salt combinations for catalyzing the coal char-CO_2 acceptor (lime)—steam and the char-oxygen-steam reactions. The purpose of this investigation is to provide catalyst performance characteristics so that a preliminary assessment of the technical and economic feasibility of producing hydrogen and other synthetic fuels by means of catalytic coal/char gasification can be made.

STEAM-IRON PROCESS

REFER ALSO TO CITATION(S) 18

371 (FE—2435-4) Development of the steam-iron process for hydrogen production. Project 9010 quarterly report No. 1, July 1—September 30, 1976. Aug 1977. Contract EX-76-C-01-2435. 58p. Dep. NTIS, PC A04/MF A01.

The overall program plan has been divided into seven tasks: (1) Reactor System Start-Up, (2) Reactor System Variables Study, (3) Design of Static Blade Test Equipment, (4) Kinetic Studies, (5) Char Evaluation, (6) Attrition Studies, and (7) Lift-Line Studies. Task 1 was initiated on July 15 when the mechanical work in the pilot plant was completed. The objective of this task is to achieve controlled operation of the producer and the steam-iron reactors. Work completed during this quarter included clearing the process lines in the reactor area and starting up the natural gas and air compressors, air heaters, and preheat burners in the producer reactor. The objective of Task 4 is to develop improved solids, with high chemical reactivity, high attrition resistance, and no tendency to agglomerate, for use in the steam-iron reactor. During this quarter, 24 reactivity tests and 25 attrition tests were conducted with iron-containing solids prepared by impregnation, coprecipitation, and leaching. The objective of Task 5 is to test chars for future use in the steam-iron producer reactor. Six tests were conducted using a six-port gas distributor with Western Kentucky bituminous char No. 2 and Montana subbituminous coal char No. 1. The objective of Task 6 is to establish the effects of particle size, gas velocity, and gas density on the attrition characteristics of iron ore and char. During the present quarter, 20 tests were conducted, 17 with siderite ore and three with lignite char. The objective of Task 7 is to establish the effects of solids flow and gas velocity on the pressure-drop characteristics of the dense-phase lift and of the transition zone between the dense- and lean-phase lifts. An existing low-pressure, solids-recirculation process development unit was modified to simulate the solids flow configuration of the steam-iron reactor, and shakedown tests were initiated this quarter.

PARTIAL OXIDATION PROCESSES

REFER ALSO TO CITATION(S) 364

STORAGE

CHEMISORPTION

372 (BNL—23046) Applications of metal hydrides. Reilly, J.J. Aug 1977. Contract EY-76-C-02-0016. 38p. (CONF-770823—2). Dep. NTIS, PC A03/MF A01.

From International symposium on hydrides for energy storage; Geilo, Norway (14 Aug 1977).

The practical application of metal hydrides is discussed with primary emphasis on their use as energy storage media. Specific applications include automotive, utility load leveling, thermal storage, and hydride compressors. (LK)

373 Metal hydrides. pp 461-534 of In Latest literature on hydrogen technology. Tokyo, Japan; ISU (1975). (In Japanese)

General investigation into metal hydrides is described. The report is divided into six parts, namely (1) hydrogen energy system with metal hydrides, (2) reactions between metals and hydrogen, (3) physical and chemical properties of metal hydrides, (4) thermodynamics of metal hydrides, (5) kinds of metal hydrides, and (6) summary. The kinds of hydrides are $FeTiH_2$, AB_5H sub(x) (A=rare earth metal and B=Co or Ni), $MgH_2(MgD_2)$, Mg_2CuH_2, Mg_2NiH_4, VH - VH_2 and NbH_2. The greatest merits in the utilization of metal hydrides are in that hydrogen can be stored in the form of solid more densely than liquid hydrogen at room temperature, and that metal hydrides are highly safe. The demerits are supposed as follows. The stored amount of hydrogen per unit weight is relatively small. The reaction of hydrogen with metals is apt to be affected by the impurities contained in the hydrogen gas. Fine powdered hydrides are rapidly oxidized and sometimes cause explosions. The resources of the metals for storing hydrogen are short in the world. The costs of utilizing metal hydrides are relatively high. Consequently, metal hydrides may perhaps be used for small scale, movable facilities such as automobiles, but not for large scale facilities. Such metals may be limited to Li, Al, and Mg or their alloys, taking the automotive use into consideration.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 364, 365

SAFETY

374 Safety and environmental problems of hydrogen. pp 845-866 of In Latest literature on hydrogen technology. Tokyo, Japan; ISU (1975). (In Japanese)

The investigation into the safety and the environment problems of liquid hydrogen as clean energy in the year 2,000 is described. The first part is an introuction. The second part deals with the general propeties of hydrogen in the forms of gas, liquid and solid, the inflammability and explosiveness, the chemical reactivity,

the corrosiveness and fragile destruction, and hydrogen-detecting and analyzing methods. The third part deals with the safety-preservation distance, the anti-explosion facilities, the safety measures for manufacturing, storing and transporting hydrogen, and measures to cope with accidents and related regulations. The fourth part deals with the effects of future mass production and usage on the environment. The radioactive waste treatment and the hot water discharge in the hydrogen production with nuclear energy must be more severely controlled than at present. The mercury system in the multistage thermal decomposition process must be a completely closed system. The waste cells containing yttrium and ytterbium must be disposed of so that they do not cause secondary pollution. In the asbestos diaphragm for water electrolytic cells, attention must be paid to cancer. The oxygen produced from water electrolytic cells must be exhausted so that it does not contaminate the atmosphere. The design for removing water as a reaction product must be required so that moisture does not increase locally. Even if hydrogen is used as fuel NO sub(x) removal technique is necessary.

PROPERTIES

REFER ALSO TO CITATION(S) 1148, 1237

375 (AD-A—041340) **A shock tube study of the $H_2/O_2/CO/Ar$ and $H_2/N_2O/CO/Ar$ systems. Technical report.** Dean, A.M.; Steiner, D.C.; Wang, E.E. May 1977. Contract N00014-75-C-1143. 33p. (SQUID-UMO—2-PU). NTIS PC A03/MF A01.

Emissions at 450 nm and 4.27 micrometers have been measured when a variety of mixtures containing H_2, CO, either O_2 or N_2O, and Ar were heated behind reflected shock waves to temperatures of 2000-2850 K and total concentrations near 5 x 10 to the 18th power molecule/cc. These emissions were used to obtain absolute concentration - time data for both oxygen atoms and carbon dioxide. The data were then compared with the results of numerical integrations of the likely mechanisms. It was observed that quantitative agreement between calculations and observations were obtained for the $H_2/CO/O_2/Ar$ system using recent high temperature literature rate constants. For the $H_2/CO/N_2O/Ar$ system, the rate constant for the reaction: H + N_2O yields N_2 + OH was adjusted so as to fit the data. Here it was found that a good fit to both (O) and (CO_2) profiles could be achieved with k = 3 x 10 to the -9th power exp(-113kJ/RT) cc/molecule. Comparison with data at lower temperatures suggests that this might be another example of a 'Non-Arrhenius' rate constant. The implications of these results to studies of hydrocarbon oxidation are discussed.

376 **Direct-connect tests of hydrogen-fueled supersonic combustors.** Waltrup, P.J.; Dugger, G.L.; Billig, F.S.; Orth, R.C. (Johns Hopkins Univ., Laurel, MD). pp 1619-1629 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

Direct-connect tests of hydrogen-fueled supersonic combustors were made using arc-heated air at combustor inlet Mach numbers of 2.9 to 3.2. Various axisymmetric combustor geometries of 5.89 and 6.96-cm-inlet-I.D. were investigated with fuel injected from the wall either from a ring of equally spaced holes normal to the air stream, or from a circumferential slot oriented 45° downstream. The hole-type injectors consistently gave the better results due to better fuel penetration. The effects of fuel and air temperatures and combustor wall temperature, length, shape, and area ratio were investigated. Performance comparisons and test evaluations are based on calorimetrically determined combustion efficiencies and on pressure, temperature, and heat flux measurements along the combustor walls and instream measurements of pressure and gas composition in the combustor exit plane. A theoretical model of the supersonic combustion process which includes a pre-combustion shock-compression is used to explain the character of the observed pressure distributions and to assess the effects of the measured heat transfer rates, deduced wall shear and combustor geometry on performance.

377 **Dependence of turbulent burning velocity on turbulent Reynolds number and ratio of laminar burning velocity to rms turbulent velocity.** Abdel-Gayed, R.G.; Bradley, D. (Univ. of Leeds, Eng.). pp 1725-1735 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

Measurements are reported of premixed hydrogen-air turbulent burning velocities, made by the double kernel method during explosions. Turbulence was created by four high speed fans within the explosion vessel. The method is described for calibrating the system, which is capable of giving high values of turbulent Reynolds numbers. The values obtained are compared with those of many other workers, over a wide range of burning conditions, mixtures and turbulent parameters. The ratio of turbulent to laminar burning velocity correlates well with both the turbulent Reynolds number and the ratio of laminar burning velocity to r.m.s. turbulent velocity. The use of hydrogen-air mixtures has extended the data on premixed turbulent combustion to regimes with higher values of the last dimensionless ratio. At high values of the ratio there is evidence of a wrinkled laminar flame structure, but at lower values a small scale eddy structure seems to be dominant. There is discussion on these findings, which accord the theoretical expectations.

OTHER SYNTHETIC AND NATURAL FUELS

REFER ALSO TO CITATION(S) 1064

PROPERTIES

REFER ALSO TO CITATION(S) 1233

378 (PB—266727) **Quenching methane-air ignitions with water sprays. Report of investigations.** Sapko, M.J.; Furno, A.L.; Kuchta, J.M. 1977. 19p. (BM-RI—8214). NTIS PC A02/MF A01.

Laboratory-scale flammability experiments were conducted to investigate the possible use of water spray systems for inerting or quenching mine-gas ignitions, such as those encountered at the working face of a coal mine. The inerting results for premixed methane-air-water mixtures indicated that water droplets of less than 10 micrometer tended to be as effective as the vapor. Water requirements for inerting of such mixtures were much smaller than those necessary for quenching the sustained flame propagation by the application of water sprays. The minimum water mass concentration for quenching methane-air flames increased linearly with increasing droplet diameter (surface weighted mean) and decreased with increasing spray temperature, whereas the droplet surface area required per unit volume was essentially constant for a given gas mixture composition. The practical limitations of water quenching and inerting systems are discussed and data extrapolations indicated that a quenching system may be feasible for the long-wall mining application.

379 (PB—266752) **Chemical flame inhibition using molecular beam mass spectrometry. An examination of the partial equilibration hypothesis and radical recombination in 1/20 atm methane flames. Report of investigations.** Biordi, J.C.; Lazzara, C.P.; Papp, J.F. 1977. 34p. (BM-RI—8222). NTIS PC A03/MF A01.

Radical and stable species concentration profiles determined in 0.042 atm slightly lean CH4-O2-Ar flames were used to test the partial equilibrium hypothesis for several bimolecular reactions in the primary and secondary reaction zones. The reactions examined were (1) H+O2=OH+O, (2) O+H2=OH+H, (3) OH+H2=H2O+H, (4) OH+OH=H2O+O, (5) CO+OH=CO2+H, (6) Br+HBr=H+Br2, (7) H+HBr=H2+Br, Balance occurs, except for reaction (6), only whenthe maximum flame temperature is reached. The important recombination reactions were judged to be H+OH+M yields H2O+M and H+O2+M yields HO2+M with rate coefficients of 5 x 10 to the 15th power(cm to the 6th power)/(mole squared) sec for M=Ar at T= 1750 + or - 150K.

380 **Mass-spectrometric investigation of propane photoionization at high temperature.** Potapov, V.K.; Novosel'tsev, A.M.; Komarov, V.N.; Kupriyanov, S.E. (Nauchno-Issledovatel'skij Fiziko-Khimicheskij Inst., Moscow (USSR)). **11**: No. 1, 32-37(Jan 1977). (In Russian).

11 refs.; 4 figs.; for English translation see the journal High Energy Chem.

The effect of the temperature in the range from 300 to 1000°K on the partial cross sections of production of molecular and fragment ions on photoionization of propane has been studied. The functions of ion distribution according to the excitation energy have been determined by the first-derivatives method and from data on the spectra of threshold photoelectrons. The temperature dependences of photoionization mass spectra have been measured with the aid of a high-temperature ion source. The theoretical temperature dependences of the propane mass spectrum obtained by the method of 'energy additivity' and first derivatives of the ion current agree with the experimental data. It is shown that taking into account the dependence of the photoionization cross sections on the energy and on the contribution from the autoionization processes while finding

the excitation energy distribution makes it possible to obtain the best agreement between the calculated and experimental data.

381 Scaling of radiative characteristics of turbulent diffusion flames. Markstein, G.H. (Factory Mutual Research Corp., Norwood, MA). pp 1407-1419 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

The following measurements were performed on single buoyancy-controlled turbulent propane diffusion flames within the range 44 less than or equal to q less than or equal to 412 cm^3/s of fuel flow rate q: (1) total radiative power P, determined with a wide-view-angle radiometer, (2) total radiative power ΔP emitted by a horizontal flame slice of known height Δz, measured with a wide-view-angle radiometer that looks at the flame through a horizontal slit, and (3) radiance emitted along a flame diameter, N/sub max/, measured with a collimated beam radiometer. The latter two quantities were measured simultaneously as functions of height z above the burner nozzle over the entire length L of the flame. Total radiative power was found to scale with the first power of flow rate, P = chi Q = chi Δh/sub c/q, where the fraction chi of total rate of heat release Q emitted as radiation was 0.264 and Δh /sub c/ = 86.831 J/cm^3 is the heat of combustion per unit volume of fuel. From the local radiative properties $S = \Delta P/\Delta z$ and N/sub max/, flame diameter $D = \pi^{-2} S/N$/sub max/ and volumetric radiant power $p = 4\pi^3 N^2$/sub max//S were derived. It was found further that the dependence of the data on flow rate q could be scaled by power law relationships, with the dependence on height z expressed by two dimensionless functions s(zeta), n(zeta) of the dimensionless height zeta = z/L.

382 Aerodynamic and flame structure within a jet-stirred reactor. Bradley, D.; Chin, S.B.; Draper, M.S.; Hankinson, G. (Univ. of Leeds, Eng.). pp 1571-1581 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

Computer modelling of a conical, jet-stirred reactor is described. Premixed methane-air enters in a central jet and the chemistry is modelled by two global reactions, one for the disappearance of methane, the other for the oxidation of carbon monoxide. To eliminate the need for a third, buffer, reactive zone, the water gas equilibrium is assumed. The restrictive nature of this is discussed. Turbulence is modelled by reference to hot wire anemometer measurements in air flow. Certain difficulties were experienced in deriving the length scale. Computed results reveal a flame structure within the reactor, which is not homogeneous. Computed gas compositions and temperatures are compared with experimental measurements of these under identical conditions. Agreement is fairly good, but the global reaction rates which gave the best match are lower than those of previous workers. Chemical heat release rates are obtained from the program and the profiles of these compare with those of positive ion concentrations, measured by an electrostatic probe. There is a wide scatter in measured electron temperatures.

383 Computer modeling of combustion in a longwell jet-stirred reactor. Wormeck, J.J.; Pratt, D.T. (Washington State Univ., Pullman). pp 1583-1592 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

Recent emphasis on air pollution control requires that detailed knowledge of the flow field and species distribution inside steady flow, high-intensity combustors be obtained. In this study, a computer program was developed which solves chemically reacting turbulent flows using detailed chemical kinetics and a two-equation turbulence model with the complete, compressible, elliptic steady-state fluid flow equations in spherical-polar coordinates for a Longwell jet-stirred reactor. The procedure can describe combustion processes which are controlled by both mixing and chemical kinetics rates when both rates are finite, and converges to a solution for all reaction mechanisms and operating conditions considered. Radiation heat transfer and finite-rate micromixing (molecular diffusion) were not considered in this application. Results are presented for stoichiometric one-atmosphere combustion of methane and air, utilizing a 34-reaction mechanism with 19 species, including NO/sub x/ formation. In all, 25 transport equations were solved simultaneously by two different numerical algorithms: one suitable for the mildly non-linear differential equations of continuity and momentum (fluid flow equations), and the other for the non-linear energy and highly non-linear chemical species equations (thermochemical equations). The fluid flow equations, together with the "k-d" turbulence model of Launder and Spalding, were solved by reformulating an existing hydrodynamic computer code by Gosman and Pun in spherical-polar coordinates, while the thermochemical differential equations were solved for a given reaction mechanism by a new computational procedure developed by the authors. The resulting two sets of equations are solved by "super-iteration" between the two procedures until convergence is achieved. The limited experimental results available compare favorably with the predictions obtained.

384 Flame quenching in turbulent flowing gaseous mixtures. Ballal, D.R.; Lefebvre, A.H. (Cranfield Inst. of Tech., Bedford, Eng.). pp 1689-1698 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

A series of tests has been carried out on flowing combustible mixtures in order to examine the influence of various flow parameters, notably pressure, velocity and turbulence, on quenching distance. A wide range of mixture compositions was employed. In some experiments the nitrogen in the air was partially or totally replaced with oxygen, while in others the nitrogen was replaced by various inert gases such as argon, helium and carbon dioxide. The purpose of these variations in chemical composition was to try and distinguish between the relative importance of thermal and diffusional mechanisms in the quenching of hydrocarbon flames. The fuels employed were methane and propane. The tests were conducted in a 9 cm square working section through which the combustible mixture flowed at various levels of pressure and turbulence intensity and at velocities up to 30 m/sec. At each test condition the spark energy required to ignite the flowing mixture was measured for several different values of electrode gap width. By plotting a graph of ignition energy against gap width, the quenching distance was obtained as the gap width corresponding to minimum ignition energy. The results obtained generally confirmed the importance of thermal diffusion processes, even at the highest flow velocities. Quenching distance was found to increase with increase in turbulence intensity and to diminish with increases in pressure and laminar flame speed. No appreciable effect of turbulence scale or flow velocity was observed. Analysis of the experimental data showed that for turbulent, flowing mixtures the quenching distance is obtained as the product of the laminar value and a factor containing the term $(u'/S/\text{sub } L/)^{0.5}$ which takes into account the additional quenching due to turbulent diffusion.

385 Multiple stationary states and NO/sub x/ production for turbulent flames in refractory tubes. Bernstein, M.H.; Churchill, S.W. (Univ. of Pennsylvania, Philadelphia). pp 1737-1745 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

Multiple stationary states for the combustion of premixed propane and air in turbulent flow through a refractory tube were predicted by Chen and Churchill on the basis of a theoretical model. The primary objective of this work was to investigate the existence of such multiplicity experimentally. A number of stable stationary states were found in a 3/8-in. tube with the flame fronts grouped in two regions just as predicted. The exact number of stable, stationary states within these two groups is still uncertain because of the very close spacing of the flame fronts. The qualitative and quantitative confirmation of the predictions supports the premise of the model that the combustion process in the tube is controlled by wall-to-wall radiation, conduction in the tube wall, convection of heat between the wall and gas stream, and homogeneous chemical kinetics. A second objective was to determine the thermal and chemical characteristics of these flames. The thermal behavior was found to be essentially the same for each of the states, except for the location of the flame front. However the production of NO/sub x/ (as NO) was found to vary from 32 to 5 ppM as the flame front location shifted down the tube from state to state at the same total flow rate and propane-to-air ratio, or with a decreasing propane-to-air ratio or with an increasing total flow rate. These concentrations are rationalized quantitatively on the basis of a gross kinetic model. The corresponding CO concentrations varied from 0.08 to 0.41 percent. These values are also found to be controlled by chemical kinetics. The very low NO/sub x/ concentrations are attributed to the short residence times at high temperature, essentially planar flow, minimal back-mixing and minimal acoustic oscillations, all of which are characteristic of combustion in turbulent flow through a refractory tube.

386 Laser velocimeter measurements in a turbulent flame. Moreau, P.; Boutier, A. (Office National d'Etudes et de Recherches Aerospatiales, Chatillon, France). pp 1747-1756 of In Sixteenth sym-

posium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

Measurements of mean velocity, turbulence rate and velocity fluctuations were performed in a constant area combustion chamber, where a premixed air-methane flow is ignited and stabilized by a parallel flow of hot gases acting as a pilot flame. The combustion produces an acceleration of the flow and transverse velocity gradients. Turbulence increases as the combustion develops, velocity fluctuations being maximum in the reaction zone. The influence of the inlet turbulence intensity and the velocity ratio between main stream and hot jet have been investigated; generally speaking, the phenomena are similar. The r.m.s. transverse velocity fluctuation obtained during the tests does not seem to be increased by combustion, and the Reynolds stress u'v' is significant only in the neighborhood of the mixing zone. The numerical prediction of mean velocity and velocity fluctuation leads to a fairly satisfactory agreement with experimental results: the turbulence increase in the combustion zone seems to be closely related to the velocity gradient produced by the flame.

387 Soot concentration field of turbulent propane/air diffusion flames. Becker, H.A.; Yamazaki, S. (Queen's Univ., Kingston, Ont.). pp 681-691 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

A systematic study has been made of soot concentration in free turbulent propane/air diffusion flames. Sampling probes and a lightscatter technique were used; the latter also allowed detection of soot concentration fluctuations. The relative intensity of the fluctuations is very high, while the integral spatial scale is rather small. The behavior of the intensity is essentially as expected from the theory of scalar fluctuations given by one of us at the Fifteenth Symposium. The results as a whole suggest that the soot concentration field is mixing-controlled and the principal aerodynamic performance parameter is the Richardson ratio Ri/sub L/ is identical with $\pi/4$ g rho /sub infinity/ L^3/G_0, where g is acceleration due to gravity, rho/sub infinity/ is air density, L is flame length, and G_0 is the jet source momentum flux. The results span the transition between forced-convection and natural-convection flames. Some results are also given on acetylene flames.

388 Characteristic times for combustion and pollutant formation in spray combustion. Tuttle, J.H.; Colket, M.B.; Bilger, R.W.; Mellor, A.M. (Purdue Univ., West Lafayette, IN). pp 209-219 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

The dominant physical processes in a liquid spray fueled burner (fuel evaporation, turbulent mixing, and chemical reaction) are characterized by time scales which typify the importance of each process. Guided by a physical model of the flame structure in the wake of a disc with liquid fuel injected into the wake region from the center of the disc, the developed characteristic times are combined to form burner output correlating parameters. The success of these parameters is demonstrated by the correlation of both carbon monoxide and oxides of nitrogen exhaust emissions from the disc burner for various geometries, a wide range of burner operating conditions, and two different fuels. In addition since carbon monoxide and oxides of nitrogen emissions originate primarily in separate regions of the flame, analysis of the characteristic times reveals a means of optimizing the burner geometry to minimize pollutant emissions.

389 Diffusive catalytic combustion. Dongworth, M.R.; Melvin, A. (British Gas Corp., London). pp 255-275 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

Catalytic combustion at temperatures down to about 580°K is used in commercial heating applications. In this paper the role of the catalyst in diffusive catalytic combustion is discussed for methane and propane as fuels with platinum catalysts. Problems of modelling are discussed for the diffusive-convective flow between catalyst particles and for the diffusion-reaction balance on the active surface. For these catalysts, it is concluded that the Thiele modulus for the reaction is high, the effectiveness factor for the catalyst is low and the reaction is thus diffusion-controlled. These conclusions are supported by experimental results which show for methane that the diffusive-convective flow in the gas between the catalyst particles is barely affected by the very fast catalytic reaction occurring on the surface. Experiment also suggests that cracking of the methane is an important feature of the process. It is suggested that cracking may have two important influences on the combustion: (i) as a source of hydrogen to sensitise the methane oxidation and (ii) as a source of carbon which, in effect, acts as a poison for the catalytic process. A similar picture is provided by the catalytic combustion of propane. Limitations to the potential of catalytic combustion in its present state of development are discussed.

390 Soot nucleation kinetics in premixed methane combustion. Lester, T.W. Wittig, S.L.K. (Purdue Univ., West Lafayette, IN). pp 671-680 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

The reflected shock region of a conventional shock tube was used to study soot formation from rich methane combustion. The combustion environment, reactant partial pressures of approximately one atmosphere, and temperatures exceeding 1800°K, simulated conditions in practical systems. The simultaneous time-resolved observation of ion precursors, ions and neutral species along with the nascent soot particles in the homogeneous reflected core region provided unambiguous kinetic data about the earliest stages of soot formation. Emission spectra of CH^0(4315 A) and C_2^0(5165 A) and Langmuir probe current histories of chemi-ions paralleled each other and changed radically in appearance from fuel-lean combustion to rich combustion conditions. Electric fields of moderate intensity were applied across the reaction zone to control ion-electron recombination. At equivalence ratios less than two, the soot production was extinguished while at equivalence ratios approaching three, an enhancement of soot formation was achieved. These observations confirm the presence of a previously proposed dual nucleation path. An analytical study of the gas-phase reaction mechanism prior to the nucleation of soot was undertaken using existing rate data. The effects of electric fields were modeled by eliminating the ion-electron recombination step since the electron concentration will be drastically reduced in an electric field of appreciable strength. The analytical results suggest that the dual nucleation path is a tenable concept in the combustion system studied.

391 Study of the soot nucleation zone of rich methane—oxygen flames. D'Alessio, A.; Di Lorenzo, A.; Borghese, A.; Beretta, F.; Masi, S. (Univ., Naples). pp 695-708 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

Some aspects of the soot nucleation processes which take place in the reaction zone of an atmospheric pressure premixed flat methane/oxygen flame have been studied using a laser light scattering method and a gas chromatographic technique. A range of CH_4/O_2 ratios of 0.9 to 1.27 was covered and the temperatures of the flames were varied by altering the inlet flow rate. The maximum concentration of C_2H_2, C_4H_2 and C_4H_4 is increased when a higher $R = CH_4/O_2$ ratio is used and, for the same R ratio, when the flame has a higher combustion temperature. Higher combustion temperatures decrease the contribution of soot particles to the measured Q/sub vv/ intensity. The analysis of the experimental results shows that the formation and evolution of C_2, C_3 and C_4 unsaturated hydrocarbons does not appear to be a process which takes place before soot nucleation. A part of the scattered signals in the first reaction zone is due to highly depolarized "anelastic" effects, whereas the depolarization in the burned gas region is due mainly to the anisotropy of the soot particles. The minimum particle size observed, determined by the scatter/extinction method, is around 20A and the initial soot number concentration has a maximum of 10^{13} cm^{-3} for the richest flame studied.

392 Optimum condition for ignition of gases by composite sparks. Kono, M.; Kumagai, S.; Sakai, T. (Tokyo Univ.). pp 757-766 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

To determine the optimum ignition condition for sparks consisting of a capacitance spark followed by a dc- (glow) or ac-discharge (1 MHz), the effects of gap width, electrode configuration, mixture strength, spark duration, and energy distribution between the two components on the minimum ignition energy were investi-

gated, using a quiescent propane-air mixture. The condition in question is conveniently characterized by the optimum spark duration for which the minimum ignition energy is lowest and the corresponding energy value. For a dc-discharge spark, the well-defined optimum spark duration varies from about 50 to 300 μsec and the minimum ignition energy for spark durations larger than the optimum increases in different modes, depending on the mixture strength and the quenching effect of spark electrodes. For an ac-discharge spark, the optimum condition for ignition is much the same as for a dc-discharge spark, but the minimum ignition energy and the spark duration are always proportional to each other above the optimum, and therefore the optimum spark duration is easily obtained up to about 5 msec. Flash-schlieren photographic observations of the initial behavior of the spark kernel confirmed that such differences in the mode of minimum ignition energy are related to electrostatic attraction by the negative electrode.

393 Spectral radiance growth, flame temperatures, and flammability behavior of large-scale, spherical, combustion waves. Hertzberg, M.; Johnson, A.L.; Kuchta, J.M.; Furno, A.L. (Bureau of Mines, Pittsburgh). pp 767-776 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

The absolute spectral radiances of the infrared emissions from spherical combustion waves in methane-air mixtures were measured as a function of methane concentration, nitrogen dilution, and CF_3Br addition. Data were obtained for the spectral range 1.7 to 4.8 μm, in a 3.66 meter (12 ft.) diameter spherical vessel, from the time of ignition to complete combustion. Radiance growth patterns for the H_2O and CO_2 bands are resolvable into an early stage of emissivity growth and a subsequent stage of adiabatic compression. The absolute radiance of the CO_2 band peak near 4.4μm is used to obtain measured flame temperatures, which are compared with calculated adiabatic values. Measured temperatures for the more rapidly propagating methane-air and nitrogen-diluted mixtures are nearly identical to adiabatic values. The radiance data are spectrally integrated to obtain broad-band emissivities for emission paths up to (p/sub H_2O/ + p/sub CO_2/) L approximately equal to 7 meter atm, and temperatures as high as 2550°K. For methane-air mixtures diluted with 2% to 4% Halon, flame temperatures are significantly lower than adiabatic values during the early stages of inhibited propagation. This is followed by a rapid stage of uninhibited combustion which generates near-adiabatic compression and/or turbulence. Two possible mechanisms for the reduction in Halon effectiveness are selective diffusional demixing of the CF_3Br molecule and changes in the relative significance of pressure-dependent kinetic pathways. Low-frequency radiance oscillations are observed for all near-limit mixtures, and some general estimates of large-scale propagation behavior are made in terms of a buoyancy-induced Reynolds number.

394 Investigations into the structure of jet diffusion flames using time-resolved optical measuring techniques. Ballantyne, A.; Bray, K.N.C. (Univ. of Southampton, Eng.). pp 777-787 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

This paper describes an investigation into the turbulent structure of small jet diffusion flames, using a variety of measuring techniques, each being capable of time resolution. These include laser Doppler anemometry, quantitative Schlieren, cross-beam correlation techniques and thermocouple probes. Spectra are reported. The Schlieren spectra display both high and low frequency structures. In the flames the high frequency peaks, which are associated with vortex shedding, are found to be significantly different from those observed in the equivalent cold jets. Both the velocity and Schlieren spectra indicate that heat release has considerable influence upon the dissipation of the higher wave number turbulence fluctuations. The Schlieren spectra are dominated by a low frequency phenomenon, which appears to be of a quasi-laminar nature. This structure is found to be a well defined oscillation in the laminar flames; although undergoing a spectra broadening, it persists in the higher velocity turbulent flames investigated. Comparison of these spectra with far field noise spectra shows significant differences, although again indicating a dominance of low frequency structure.

395 Experimental investigation of an arc-heated stirred reactor. Kimura, I.; Imajo, M. (Tokyo Univ.). pp 809-815 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

A small stirred reactor equipped with electrodes was developed, in which high-temperature radicals produced by an arc discharge are dispersed through a reacting mixture. With the electrode arrangement finally selected, the stability of the arc discharge was satisfactory up to the maximum loading used without seeding (no interruption and negligible fluctuation of the current). The result obtained using a lean propane-air mixture (phi = 0.62) showed that quite small additions of electrical power (boost ratio: 4.5 approximately 6%) produce large increases in throughput (200% or more), keeping combustion efficiency relatively high. It was shown also that a diluted mixture (phi = 0.43) outside the flammability region can be reacted steadily with small additions of electrical power (e.g., 10%) with reasonable throughput and combustion efficiency (e.g., N/VP/sup 1.8/ = 4 and combustion efficiency approximately equal to 80%). Under the assumption of an adiabatic, perfectly-stirred reactor, burning-rate correlations based on reaction rate theory were derived, using the data for air loading and reacting gas temperature or oxygen consumption efficiency. Although the accuracy of the results is limited because of imperfect mixing and relatively large heat loss, it was confirmed that with electrical power, the value of the apparent activation energy is very low, whereas without electrical power a normal value is obtained. This fact seems to suggest that high-temperature radicals, produced by arc discharges, participate actively in the rate-limiting process of the combustion reaction.

PREPARATION

396 Conditions for reduction of iron molybdenum-tungsten catalyst for ammonia synthesis. Simulina, N.A.; Karibdzhanyan, N.A.; Lachinov, S.S.; Anfimov, V.A.; Shumlyakovskii, Ts.I. No. 2, 39-41(1977). (In Russian).

For English translation see the journal Sov. Chem. Ind.

The reduction of Fe-Mo-W catalyst MB-5, used for synthesis of ammonia, has been studied in the reactor of extracolumn reduction. The results obtained have been compared with similar results for the catalyst CA-1. It has been shown that reduction of the catalyst MB-5 proceeds more intensive and is completed at lower temperature and for a shorter period of time. The samples of the catalyst MB-5 discharged from different layers in the reactor are more active than CA-1 reduced under identical conditions.

CHEMICAL SYNTHESIS

397 (CONF-760838—, pp 15p, Paper 20) **Mobil process for the conversion of methanol to gasoline.** Wise, J.J.; Silvestri, A.J. (Mobil Research and Development Corp., Princeton, NJ). 1976.

From 3. annual international conference on coal gasification and liquefaction; Pittsburgh, Pennsylvania, United States of America (USA) (3 Aug 1976).

In 3rd international conference on coal gasification and liquefaction.

The Mobil Process is a component of the overall process for converting coal to gasoline via gasification of the coal and production of methanol from the resulting synthesis gas. The Mobil Process, which uses a proprietary catalyst and is highly exothermic, is briefly outlined. The one potential problem in product quality is the presence of durene, the C_{10} alkylbenzene, in the gasoline. The quantity of durene produced can be controlled by reaction conditions. The economics and thermal efficiency of the coproduction of gasoline and SNG in the gasification of coal are discussed in some detail. (JSR)

398 Kinetic model with axial dispersion for the hydrogenation of CO to CH_4 in slurry reactor. Schmal, M. (Cidade Univ., Rio de Janeiro). 7: No. 2, 169-179(Jun 1976). (In Spanish).

The dispersion model was used by studying the kinetics of the hydrogenation of carbon monoxide to methane. The superposition method of Hoffmann and Schonemann was employed determining initially the reaction rate for the ideal model including the physical adsorptions according to the Freudlich isotherm, the superficial chemical reaction and the convection mass transfer in the liquid phase. Then determining the distribution function of the residence time, the final conversion with axial dispersion was calculated. The volume contraction and the influence of the conversion on the porosity and the interfacial area liquid-gas was considered. The conversion of carbon monoxide varies along the reactor position and depends on the gas superficial velocity and the concentration of the catalyst. For slow flow the initial reaction rates are large but decrease with increasing the superficial velocity. For a final conversion of 80% we obtain minimum reactor heights between 3,5 m and 4 m and a superficial velocity between 3,5 and 4 cm/s with transition laminar-turbulent flow.

PREPARATION FROM WASTES OR BIOMASS

REFER ALSO TO CITATION(S) 404, 463, 1093

ALCOHOL FUELS

399 (NTIS/PS—77/0620) **Alcohol fuels (citations from the NTIS data base). Report for 1964-Jul 77.** Cavagnaro, D.M. Jul 1977. 132p. NTIS PC N01/MF N01.

The bibliography covers Federally-funded research on alcohol based fuels that might have to be used in the future as a fuel source. The citations cover synthesis, chemical analysis, performance testing, processing, pollution, economics, environmental effects, and feasibility. (Contains 127 abstracts)

400 (NTIS/PS—77/0621) **Alcohol fuels (citations from the Engineering Index data base). Report for 1970-Jul 77.** Cavagnaro, D.M. Jul 1977. 148p. NTIS PC N01/MF N01.

Worldwide research citations discuss the new technology in the field of alcohol fuels. The bibliography covers the different blends, synthesis, processes used, properties, engine performance evaluations, economics, safety measures, pollution effects, and combustion studies. The research also covers sources from which alcohol fuels can be obtained; such as coal, solid wastes, industrial by-products, and agricultural wastes. (Contains 141 abstracts)

PROPERTIES

401 (EPA—600/2-76-212, pp 363-372) **Evaluation of the potential impact of alcohol fuels on pollutant emissions and energy requirements of area sources.** Martin, G.B. (Environmental Protection Agency, Research Triangle Park, NC). Aug 1976.

From Symposium on environment and energy conservation; Denver, Colorado, USA (3 Nov 1975).

In Symposium on environment and energy conservation.

A brief summary of information on methanol synthesis is followed by a review of the data on alcohol fuels combustion. Based on this information emission and efficiency aspects of alcohol fuels combustion in area sources (stationary combustion sources used in residential and commercial applications) are discussed. (JSR)

402 Effect of droplet interaction on ignition in monodispersed droplet streams. Sangiovanni, J.J.; Kesten, A.S. (United Technologies Research Center, East Hartford, CT). pp 577-592 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

Analysis of the combustion of fuel droplet arrays is constrained by the paucity of information on the effects of droplet interaction on ignition and flame development. An experimental and theoretical examination of the effects of interaction on ignition of a single stream of monosized fuel droplets is described. Experimentally, ignition times were measured for continuous droplet streams injected into a hot gas environment with droplet spacings ranging from hundreds of droplet diameters to slightly less than two diameters, approaching as closely as possible a cylindrical filament of liquid fuel. Apart from the change in symmetry of the environment of any one droplet as droplet spacing is decreased, closer spacing enhances the significance of the diffusion of heat and mass from the flame region surrounding burning droplets to the neighborhood of an unignited droplet. Theoretical models of ignition for the limiting droplet spacings represented by an isolated spherical droplet and a cylindrical filament of liquid are used to provide an understanding of the extent of potential droplet interaction effects on ignition time. The present investigations indicate that as droplet spacing is made smaller, interaction effects become increasingly more important for small droplets, low gas phase temperatures, and fuels of low volatility. Increases in ignition delay times of nearly four-fold are shown to be possible as droplet spacing is made very small, approaching the limit of a cylindrical filament.

CHEMICAL SYNTHESIS

REFER ALSO TO CITATION(S) 397

PREPARATION FROM WASTES OR BIOMASS

REFER ALSO TO CITATION(S) 1040

PREPARATION

REFER ALSO TO CITATION(S) 1, 486

403 Scandium activating action in the catalytic synthesis of ammonia and investigation of this effect by the method of contact potential difference and of Moessbauer effect. Rudnitskii, L.A.; Rabina, P.D.; Melik'yan, A.A.; Korneev, V.P.; Kuznetsov, L.D.; Saprykina, T.V.; Alekseev, A.M. (Gosudarstvennyj Nauchno-Issledovatel'skij i Proektnyj Inst. Azotnoj Promyshlennosti i Produktov Organicheskogo Sinteza, Moscow (USSR)). **17**: No. 4, 989-994(Jul 1976). (In Russian).

11 refs.; for English translation see the journal Kinet. Catal.

It has been shown that overheating of iron catalysts used for ammonia synthesis and promoted with scandium oxide considerably increases their activity, both specific and total. Upon prolonged overheating, specific catalytic activity decreases almost to the initial value. Changes in activity have been correlated with variations of electron work function: a decrease in phi by 0.7-0.8 eV corresponds to the highest activity; overheating causes an increase in phi almost to the initial value. Analysis of Mossbauer spectra reveals a monotonous increase in line broadening as overheating goes on. It has been assumed that a rise in catalytic activity is caused by dissociation of scandium oxide and adsorption of scandium on the surface a-Fe. This is complicated by the formation of Sc solid solution in a-Fe which results in a monotonous increase in broadening of the Mossbauer spectrum lines with time over heating. The phenomenon observed has been analyzed quantitatively.

SOLID WASTE FUELS

404 (EPA—600/2-76-212, pp 422-434) **EPA R and D program in wastes-as-fuel: an overview focusing on process environmental/energy impacts.** Huffman, G.L. (Industrial Environmental Research Lab., Cincinnati). Aug 1976.

From Symposium on environment and energy conservation; Denver, Colorado, USA (3 Nov 1975).

In Symposium on environment and energy conservation.

The USEPA is conducting a broad-based program in research and development in the area of waste utilization as alternative fuel sources. Major waste-as-fuel technologies and methods are being explored to determine their environmental and energy impacts, and to develop technology to control undesirable environmental impacts. Major processes include: use of waste as a supplementary fuel in large pulverized-coal boilers, in other types of coal-fired boilers, in oil-fired boilers, and in industrial and smaller institutional boilers; direct conversion of wastes to electricity via a gas turbine; and the pyrolytic conversion of wastes to fuel gas and fuel oil. A description of these processes is presented, as is the status of those R and D projects which encompass them. The environmental aspects of these processes are summarized, along with projections of their energy conservation attributes.

405 Planning for energy and resource recovery from solid waste in the state of New York. Rhodes, M. Troy, NY; Rensselaer Polytechnic Inst. (1976). 303p. University Microfilms Order No. 77-13,717.

Thesis (Ph. D.).

Solid waste has become an important economic factor for two reasons: the growing need of land for disposal and the increasing demands for substitute fuels. During the early 1960's New York State began to plan for solid waste disposal. State-wide planning was simplified in New York State because of the unique geographical formations of the lowlands and the bordering highlands. Approximately 95% of the solid waste is generated within 48.3% of the land area. Of the available technologies for deriving fuel from solid waste two have been chosen for this current New York State plan: (1) co-combustion with fossil fuels and (2) water wall incineration. This plan strongly recommends that the total solid waste system either local or multicommunity be studied as the solid waste energy source for either of the two proposed systems. Toward this end a mathematical systems model was developed with three sub-systems: (1) OPTMDL (Optimization Model), (2) SYSMDL (Systems Model) and (3) Economic or Funding Model. The model simulates collection, hauling, and processing costs. Environmental effects of energy recovery from solid waste incineration are minimized because of the low sulfur content of the solid waste, when used as a fuel. Other positive contributions are: reduction in fossil fuel use; recovery of ferrous, aluminum and glass resources; (3) inert landfilling with a reduction in potential fire hazard and generation of methane gas; and reduction in available land requirements for landfill sites. Data is given for other energy and resource recovery projects now planned or underway in New York State.

HYDRO ENERGY

REFER ALSO TO CITATION(S) 953

PLANT DESIGN AND OPERATION

REFER ALSO TO CITATION(S) 891

ENVIRONMENTAL ASPECTS

LAND USE AND AESTHETICS

406 (AD-A—041434) **Temperature regime of water in the near shore zone of the reservoir of the Vilyuysk hydroelectric power station.** Konstantinov, I.P. Translated from **40**: 32-34(Feb 1976). 12p. (CRREL-TL—631). Regions Research and Engineering Lab., Hanover, NH.

The thermal effect of water on frozen soil is one of the important factors involved in the reformation of the shore of artificially constructed reservoirs in areas where permafrost soil occurs. This report details the observations associated with the formation of the shores of the Vilyuysk Reservoir and the monitoring of water temperature.

SOLAR ENERGY

407 (CONF-760492—, pp 5-8) **ERDA and its role in solar energy.** Cherry, W.R. (Energy Research and Development Administration, Washington, DC). 1976.

From The solar energy fuel and food workshop; Tucson, Arizona, United States of America (USA) (5 Apr 1976).

In Solar energy: fuel and food workshop.

The ERDA program in solar energy is outlined briefly. Funding is mentioned. Under the ERDA/USDA solar thermal agricultural program, five major areas are being investigated: solar grain drying, solar crop drying, solar heating of greenhouses and rural residences, solar heating of animal shelters, and solar agricultural food processing. (MHR)

RESOURCES AND AVAILABILITY

REFER ALSO TO CITATION(S) 433, 440

408 (NASA-TM-X—71802, pp 1-3) **Solar radiation measurements at NOAA.** Riches, M.R. (NOAA/National Weather Service, Silver Spring, MD). 1975.

From Terrestrial photovoltaic measurements workshop; Cleveland, Ohio, USA (19 Mar 1975).

In Terrestrial photovoltaic measurements.

The National Oceanic and Atmospheric Administration (NOAA) through its component National Weather Service (NWS) operates a solar radiation monitoring network. The changes recommended in this network are discussed. (MHR)

409 (NASA-TM-X—71802, pp 4-9) **Solar radiation at Newport, Rhode Island.** Hickey, J.R. (Eppley Lab., Newport, RI). 1975.

From Terrestrial photovoltaic measurements workshop; Cleveland, Ohio, USA (19 Mar 1975).

In Terrestrial photovoltaic measurements.

In response to the new demand for solar radiation data, the available records are being reviewed in order to establish as complete a data set as possible back to the earliest days. Daily integral radiation on a horizontal surface for the year 1970 is shown as a function of date. This plot shows the typical yearly variations of weather for a seacoast area. Instantaneous solar noon readings on clear days are plotted for the years 1961 through 1970. The integral evaluations showing monthly integral radiation for the years 1961 through 1973 are given. Yearly integral values are shown for the years 1961 through 1973. (MHR)

410 (NASA-TM-X—71802, pp 10-11) **Measurement of insolation at DSET.** Zerlaut, G. (Desert Sunshine Exposure Tests, Inc., Phoenix, AZ). 1975.

From Terrestrial photovoltaic measurements workshop; Cleveland, Ohio, USA (19 Mar 1975).

In Terrestrial photovoltaic measurements.

Desert Sunshine Exposure Tests, Inc. is a weathering facility serving business and industry. Its capabilities in determination of solar radiation data are reviewed. (MHR)

411 (NASA-TM-X—71802, pp 12-16) **Measurement of the solar constant by pacrad on Convair 990 flights in 1968.** Kendall, J.M. Sr. (Technical Measurements, Inc., LaCanada, CA). 1975.

From Terrestrial photovoltaic measurements workshop; Cleveland, Ohio, USA (19 Mar 1975).

In Terrestrial photovoltaic measurements.

A resume is given of 35 measurements (based on 197 readings). The measurements themselves appear to be consistent within +- 0.1 percent. The causes of uncertainties in data are discussed. The cavity receptor, assembly, and radiometer are shown. (MHR)

412 (NASA-TM-X—71802, pp 17-24) **Spectral measurements of solar intensity and spectrum conditions at high altitudes (5200 to 14,000 feet) and arid (Colorado) conditions.** Hulstrom, R.L. (Martin Marietta Aerospace, Denver). 1975.

From Terrestrial photovoltaic measurements workshop; Cleveland, Ohio, USA (19 Mar 1975).

In Terrestrial photovoltaic measurements.

Previous solar cell testing has been done with simulated, extraterrestrial, solar intensity spectra; however, terrestrial solar cell applications require a knowledge of solar spectral intensity under various atmospheric conditions. Data and analyses are presented for solar spectral intensity (irradiance) conditions for high altitudes (5200 to 14,000 ft) and arid and slightly polluted atmospheric conditions. In addition, basic concepts regarding atmospheric effects, solar intensity conditions and the instrumentation used to make the measurements are discussed. (MHR)

413 (NASA-TM-X—71802, pp 25-37) **Spectral distribution of sunlight under various air mass conditions.** Seck, A. (Optical Coating Lab., Inc., City of Industry, CA). 1975.

From Terrestrial photovoltaic measurements workshop; Cleveland, Ohio, USA (19 Mar 1975).

In Terrestrial photovoltaic measurements.

Difficulties and sources of error encountered for measurements and data are detailed. It is concluded that the existing weather data and the gathering methods used are not sufficient to design an optimized silicon photovoltaic energy conversion system for a given site. Alternatives are discussed. (MHR)

414 (NASA-TM-X—71802, pp 80-81) **Proposed standard for AM1 sunlight.** Hadley, H. Jr. (Univ. of Delaware, Newark). 1975.

From Terrestrial photovoltaic measurements workshop; Cleveland, Ohio, USA (19 Mar 1975).

In Terrestrial photovoltaic measurements.

It is proposed that for evaluating solar simulators the characteristics of terrestrial sunlight be as defined by a curve of global radiation calculated in the manner used by Gates from a well defined AM0 spectral distribution and a "standard atmospheric" containing specified amounts of the scattering and absorbing materials. The AM1.0 global curve for these conditions is shown and has an integrated flux of 91.7 milliwatts/cm^2. The tabulated energy distribution is given. (MHR)

415 (NASA-TM-X—71802, pp 86-93) **Determination of diffuse radiation characteristics for application in solar energy harvesting.** Armstrong, B.H.; Dave, J.V.; Halpern, P. (IBM Scientific Center, Palo Alto, CA). 1975.

From Terrestrial photovoltaic measurements workshop; Cleveland, Ohio, USA (19 Mar 1975).

In Terrestrial photovoltaic measurements.

The current solar radiation data and the relevant radiative transfer theory are reviewed and the realistic atmospheric models are pointed out which can provide the needed description of diffuse radiation. (MHR)

416 (NASA-TM-X—71802, pp 94-97) **Low cost, large area solar simulation.** DeLeo, V. 1975.

From Terrestrial photovoltaic measurements workshop; Cleveland, Ohio, USA (19 Mar 1975).

In Terrestrial photovoltaic measurements.

The advantages of the SPECTROSUN pulsed simulator are discussed. The design features, performance, safety, and data acquisition and processing systems are covered. (MHR)

417 (NASA-TM-X—71802, pp 98-107) **Low cost, AM2 simulator.** Curtis, H. (NASA Lewis Research Center, Cleveland). 1975.

From Terrestrial photovoltaic measurements workshop; Cleveland, Ohio, USA (19 Mar 1975).

In Terrestrial photovoltaic measurements.

A low cost, AM2 solar simulator is in operation at the Lewis Research Center. It is used to test flat plate collectors for terrestrial utilization of solar energy. It could possibly be modified for continuous testing of large arrays of solar cells. The simulator is described briefly and its performance characteristics such as irradiance level, collimation angle, and spectral distribution of irradiance are presented. (MHR)

418 (NASA-TM-X—71802, pp 150) **Results of session II working group: terrestrial sunlight simulation.** Curtis, H. 1975.

From Terrestrial photovoltaic measurements workshop; Cleveland, Ohio, USA (19 Mar 1975).

In Terrestrial photovoltaic measurements.

The topics for discussion are: irradiance and spectral irradiance standards, measurement techniques for lamp source and solar

simulator systems, and lamp sources and simulator systems which accurately and reproducibly simulate terrestrial sunlight at low cost. Recommendations are given. (MHR)

419 (NASA-TM-X—71802, pp 159-166) **Spectral distribution of direct and diffuse solar energy received at sea level of a model atmosphere.** Dave, J.V. (IBM Corp. Scientific Center, Palo Alto, CA); Halpern, P.; Braslau, N. 1975.

From Terrestrial photovoltaic measurements workshop; Cleveland, Ohio, USA (19 Mar 1975).

In Terrestrial photovoltaic measurements.

Spectral characteristics of the direct and diffuse solar energy passing through a horizontal surface at the bottom of one model atmosphere are discussed. This model atmosphere corresponds to an average mid-latitude summer case without any clouds, resting on a perfectly absorbing ground, and illuminated by the Sun at 60^0 from the local zenith. Representative results of the simulation study are presented. (MHR)

420 **Simulation of synthetic weather data for the design of a solar-powered air-conditioning system.** Anand, D.K.; Allen, R.W.; Bazques, E.O. (Univ. of Maryland, College Park). pp 1121-1127 of In Modeling and simulation. Volume 7, Part 2. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P2.

Synthetic weather data, represented by a joint probability density matrix and five constants, is generated by using real weather data consisting of hourly values of dry bulb temperature and insolation. The performance of a solar powered absorption air-conditioning system is obtained using real and synthetic data. The results lead to the conclusion that synthetic data yield satisfactory results while allowing very inexpensive simulations.

ECONOMICS

REFER ALSO TO CITATION(S) 422, 486, 507, 512, 515, 1039

421 **Preferred residential solar heating and cooling systems compatible with electric utility operation.** Nathanson, D. (Arthur D. Little, Inc., Cambridge, MA); Cummings, J.E. pp 24.11-24.15 of In Proceedings of the 1977 annual meeting of the American Section of the International Solar Energy Society. Volume 1, Sections 14—25. Beach, C.; Fordyce, E. (eds.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1977).

From Solar world meeting; Orlando, Florida, USA (6 Jun 1977).

See CONF-770603—P2.

A preferred hot water and space conditioning system--from the standpoint of the electric utility and the consumer--is one that minimizes the total life-cycle cost of meeting the energy needs for a residence. The design of such a system involves a stepwise approach involving consideration of: (1) energy conservation measures applied to the building structure and heating, ventilating and cooling equipment; (2) control of electric demand by load management techniques; and (3) installation of a solar system to displace energy resources. A utility's cost of supply analysis approach was useful for evaluating systems because it was found that preferred systems cannot always be reliably selected on the basis of existing or historical rate structures for back-up electricity.

ENVIRONMENTAL, LEGAL, AND INSTITUTIONAL ASPECTS

REFER ALSO TO CITATION(S) 520

422 (DSE/115—2) **Solar energy in America's future: a preliminary assessment.** Mar 1977. Contract EY-76-C-03-0115-107. 124p. Dep. NTIS, PC A06/MF A01.

The report documents a Stanford Research Institute study of the potential roles that solar energy technologies could have for meeting U.S. energy needs over the next 45 years. Computer simulations of different energy supply projections were developed by varying the input parameters of energy demand and energy costs. Three of these projections were chosen to be developed into broader scenarios--that is, richer scripts of the future. First, the implementation measures required to realize these scenarios are delineated. Then, the economic socio-economic, sociopolitical and environmental issues associated with different energy futures are identified, and these issues are compared among the three scenarios. Finally, six major societal issues are synthesized from an analysis of the scenarios. These issues and the three scenarios are evaluated from the perspectives of individuals in different perceptual frames-of-reference.

SOLAR ENERGY CONVERSION

REFER ALSO TO CITATION(S) 414

PHOTOVOLTAIC CONVERSION

REFER ALSO TO CITATION(S) 418, 915, 1041

423 (AD-A—039995) **A solar power radiacmeter. Research and development technical report.** Nirschl, J.C. Apr 1977. 27p. (ECOM—4495). NTIS PC A03/MF A01.

A solar power radiacmeter (breadboard) design is described, based on a miniature (18 cc) ionization chamber and low power, solid-state (Field Effect Transistor, FET) electrometer. Power demand for this instrument, including DC converter, is approximately 5 mW. Preliminary experiments with a 20 sq cm silicon solar cell panel and pen light (AA size) rechargeable (NiCd) battery suggest feasibility of this approach. Solar power intake and dissipation is discussed for experiments conducted.

424 (CONF-761168—1) **Basic solar energy science in thin-film photovoltaic conversion.** Griffith, R.W. 1976. Contract W-31-109-ENG-38. 16p. Dep. NTIS, PC A02/MF A01.

From ERDA/DPR symposium on thin-film research; Pacific Grove, California, United States of America (USA) (1 Nov 1976).

The importance of basic materials research in the development and optimization of photovoltaic devices for solar energy conversion is emphasized. Some photovoltaic devices are surveyed briefly to focus attention on the role of materials problems. Four fundamental questions are asked that bear on materials science as it relates to thin-film photovoltaics in solar energy utilization. (MHR)

425 (ERDA/JPL/954328—77/1) **Methodology for designing accelerated aging tests for predicting life of photovoltaic arrays. Final report.** Gaines, G.B.; Thomas, R.E.; Derringer, G.C.; Kistler, C.W.; Bigg, D.M.; Carmichael, D.C. 1 Feb 1977. Contract NAS-7-100-954328. 139p. Dep. NTIS, PC A07/MF A01.

Current analyses dictate that for economic viability photovoltaic arrays should have a service life of 20 years or more. A need exists for meaningful accelerated tests to predict array life so that a relatively quick assessment can be made of the potential of present developmental designs and of the extent to which improvements in life are needed. The methodology developed builds upon past experience with regard to aging behavior in those material classes which are expected to be utilized as encapsulant elements, viz., glasses and polymers, and upon past experience with the design of aging tests. Accordingly, these experiences were reviewed and the results are presented. The improved methodology developed in this study is described. The first six steps of the developed methodology focus on the explicit identification of necessary engineering input information, identification of possible failure modes and environmental variables (stresses) that may affect the time rates of degradation for each failure mode without changing the failure mode, estimation of expected overall severity of each combination of environmental stresses, and analysis of severity ratings as a complete factorial experiment. Considerations of precision, accuracy, and test sensitivity are also included in the report. It is recommended that empirical, statistical, and conceptual methods be used to analyze the data resulting from the implemented accelerated test. It is also recommended that, during the test program, predictions be made both within and between stress conditions in order to generate a "track record" for predicting degradation at lower environmental stress conditions using data obtained from higher stress conditions.

426 (ERDA/JPL/954356—77/2) **Dip coating process. Silicon sheet growth development for the large-area silicon sheet task of the low-cost silicon solar array project. Quarterly report No. 6, March 22, 1977—June 24, 1977.** Zook, J.D.; Heaps, J.D.; Maciolek, R.B.; Koepke, B.; Butter, C.D.; Schuldt, S.B. 30 Jun 1977. Contract NAS-7-100-954356. 50p. Dep. NTIS, PC A03/MF A01.

The objective of this research program is to investigate the technical and economic feasibility of producing solar-cell-quality sheet silicon by coating one surface of carbonized ceramic substrates with a thin layer of large-grain polycrystalline silicon from the melt. Significant progress was made in silicon on ceramic (SOC) solar cell performance. SOC cells having 1 cm^2 active areas demonstrated measured conversion efficiencies as high as 7.2 percent. Typical open circuit voltages (V/sub oc/) and short circuit current densities (J/sub sc/) were 0.51 volt and 20 mA/cm^2 respectively. Since the active surface of these solar cells is a highly reflective "as-grown" surface, one can expect improvement in J/sub sc/ after an anti-reflection (AR) coating is applied. It is significant that single-crystal comparison cells, also measured without benefit of an AR coating, had efficiencies in the 8.5 percent range with typical V/sub oc/'s and

J/sub sc/'s of 0.54 volt and 23 mA/cm², respectively. Therefore, improvement in cell design and junction diffusion techniques should increase the efficiency of both the SOC and single-crystal cells. During this quarter the dip coating facility was inadvertently contaminated, but has since been restored to a purity level exceeding its original state. With this facility, silicon coatings were grown with a single-crystal seed attached to the substrate. Single-crystal silicon was not forthcoming, but the results were nonetheless encouraging. Several of the carbon coating types tried appear promising, including one which has high purity and can be applied uniformly by swab or airbrush.

427 (ERDA/JPL/954405—76/5) **Automated Array Assembly Task, Phase I. Quarterly report.** Carbajal, B.G. Apr 1977. Contract NAS-7-100-954405. 20p. Dep. NTIS, PC A02/MF A01.

The overall goal of the Array Automated Assembly Task, Phase I, of the Low-Cost Silicon Solar Array Project is a comprehensive assessment of the processes, conceptual designs, and new technologies required to achieve, by 1985, annual solar cell array production capability greater than 500 megawatts per year at a cost less than $500 per kilowatt. This goal is being approached from two directions. The first is to build a model or models of the costs involved in the various steps used to fabricate solar cell modules. These costs are being analyzed in terms of present-day capabilities and projected capabilities. Also, new technologies will be fitted to these models to determine the cost ranges for solar cell processing using new or emerging technologies. The second approach is to determine the cost goals for each of the processing steps. The program will then undertake a series of studies that are intended to point the way from existing and projected costs to the cost goals. The design-to-cost concept will establish allowable costs for each cell manufacture/array assembly step consistent with the 1985 cost goals. During this quarter, effort was concentrated on evaluating the technical feasibility of two key solar cell process steps, surface texture etching and patterned electroless nickel plating. Design improvements have been made on the long life LSSA module design that improve packing density (efficiency) and lower cost. A follow-on program featuring sensitivity analysis of solar cell performance versus physical parameters has been initiated.

428 (ERDA/JPL/954405—77/4) **Automated Array Assembly Task, Phase I. Annual report.** Carbajal, B.G. Mar 1977. Contract NAS-7-100-954405. 115p. Dep. NTIS, PC A06/MF A01.

This contract, a subtask of Task 4 of the LSSA Project, consists of an assessment of state-of-the-art technologies that are applicable to silicon solar cell and solar cell module fabrication. The assessment consists of a technical feasibility evaluation and a cost projection for high-volume production of silicon solar cell modules. The cost projection was approached from two directions, a design-to-cost analysis assigned cost goals to each major process element in the fabrication scheme and a cost analysis built up projected costs for alternate technologies for each process element. A technical evaluation was used in combination with the cost analysis to identify a baseline low-cost process. Since some of the technologies called for in the baseline process are still in a feasibility stage for solar cell fabrication, two alternates to the baseline process were also identified. A novel approach to metal pattern design based on minimum power loss was developed. These design equations were used as a tool in the evaluation of metallization technologies. The quantitative nature of the design equations provided a solid technical basis for the choice of a metallization technology. A hermetic module was proposed that has a high probability of meeting the 20-year life goal. Solar cell processing and module fabrication cost projections exceed the 1985 cost goal by only a factor of approximately 3.

429 (NASA-TM-X—71802) **Terrestrial photovoltaic measurements.** Scudder, L.N.; Klucher, T.M. (eds.). 1975. Contract E(49-26)-1008. 185p. (CONF-750337—; N—76-71615/26). Dep. NTIS $7.50.

From Terrestrial photovoltaic measurements workshop; Cleveland, Ohio, USA (19 Mar 1975).

Twenty-two papers, four working group reports, and two supplemental papers are included. One supplemental paper appeared previously. One paper appeared previously as Conf-750337—1. Separate abstracts were prepared for the other twenty-six reports and papers. (MHR)

430 (NASA-TM-X—71802, pp 44-50) **Solar cell performance in terrestrial sunlight.** Castle, J.A. (Spectrolab, Inc., Sylmar, CA). 1975.

From Terrestrial photovoltaic measurements workshop; Cleveland, Ohio, USA (19 Mar 1975).

In Terrestrial photovoltaic measurements.

Unlike the solar radiation outside the Earth's atmosphere, the spectral distribution and intensity of terrestrial sunlight are continually changing. As a result, predicting the output performance of a terrestrial-based solar cell array is further complicated because of the strong wavelength dependence of the cell response. The magnitude of this problem is assessed by looking at the sensitivity of the silicon solar cell output to variations in atmospheric conditions. It is found that the sensitivity of the solar cell short-circuit current with respect to incident radiation increases with increasing path length through the atmosphere. (MHR)

431 (NASA-TM-X—71802, pp 51-57) **Variation of solar cell efficiency with air mass.** Brandhorst, H.W. Jr. (NASA Lewis Research Center, Cleveland). 1975.

From Terrestrial photovoltaic measurements workshop; Cleveland, Ohio, USA (19 Mar 1975).

In Terrestrial photovoltaic measurements.

Data are provided on the variation of solar cell short-circuit current and efficiency with air mass. The solar cells studied included a conventional silicon cell, a silicon cell irradiated with 1×10^{16} electrons per square centimeter, a gallium arsenide cell manufactured about 1964, a gallium aluminum arsenide-gallium arsenide cell, and a glass-encapsulated, Kapton-covered Clevite-type cadmium sulfide cell. For the five types measured in this study it was shown that short-circuit current is directly proportional to intensity within a standard deviation of about 2 percent and that efficiency is independent of air mass within about 2 percent. (MHR)

432 (NASA-TM-X—71802, pp 58-63) **Microclimatological influences on two solar modules.** Warschauer, D.M. (Naval Weapons Center, China Lake, CA). 1975.

From Terrestrial photovoltaic measurements workshop; Cleveland, Ohio, USA (19 Mar 1975).

In Terrestrial photovoltaic measurements.

Two arrays "Brand B" and "Brand X" were purchased specified to supply a 0.8 to 0.9 ampere peak with a 4 ampere hour load per day for local China Lake conditions. Forty ampere-hour batteries were recommended by the manufacturer of each array as providing sufficient capacity to take care of periods of low insolation. The arrays were mounted side by side with the same orientation. It was concluded that a solar module is a highly nonlinear device whose performance is a function of the cell and array characteristics, the efficiency of of charge storage, the past history as represented in battery voltage and state of polarization, and the time dependent details of insolation. (MHR)

433 (NASA-TM-X—71802, pp 67-73) **Modern radiometry for photovoltaic solar conversion.** Geist, J. (National Bureau of Standards, Washington, DC). 1975.

From Terrestrial photovoltaic measurements workshop; Cleveland, Ohio, USA (19 Mar 1975).

In Terrestrial photovoltaic measurements.

The introduction of new technology into radiometry is reviewed. To demonstrate the new approach, the spectral irradiance was measured at 602 nanometers from a quartz halogen coiled coil filament lamp that had already been calibrated for spectral irradiance using the classical approach. The classical and the new approaches are diagrammed and results compared. (MHK)

434 (NASA-TM-X—71802, pp 74-79) **Solar simulator spectral and irradiance degradation.** Lunde, A.R. (Boeing Co., Seattle, WA). 1975.

From Terrestrial photovoltaic measurements workshop; Cleveland, Ohio, USA (19 Mar 1975).

In Terrestrial photovoltaic measurements.

The measured changes of a solar simulator during a solar cell degradation study are described briefly and how these changes might influence the test results is discussed. (MHR)

435 (NASA-TM-X—71802, pp 106-112) **Analysis of the influence of cell characteristics on the spectral sensitivity of Cu_2S—CdS solar cells.** Rothwarf, A. (Univ. of Delaware, Newark). 1975.

From Terrestrial photovoltaic measurements workshop; Cleveland, Ohio, USA (19 Mar 1975).

In Terrestrial photovoltaic measurements.

For Cu_2S-CdS solar cells, the photovoltaic response depends on the absorption coefficient α, the thickness of the Cu_2S layer d, the electron diffusion length L, the surface recombination velocity S, grain radius R, the drift field in Cu_2S F_1, the interface recombination velocity S/sub I/, the field in the CdS space charge region F_2, and the mode of operation of the cell (front wall, back wall, and reflection modes). The expected light generated current density j/sub L/ was calculated as a function of α, d, L, S, R, F, S/sub I/, and F_2 for the four modes of cell operation. The expressions are complex, and graphical results are given for some values of the parameters.

436 (NASA-TM-X—71802, pp 113-119) **Spectral effects in CdS/Cu_2S solar cells.** Hadley, H. Jr. (Univ. of Delaware, Newark). 1975.

From Terrestrial photovoltaic measurements workshop; Cleveland, Ohio, USA (19 Mar 1975).

In Terrestrial photovoltaic measurements.

The spectral distribution of I/sub sc/ corrected to a uniform intensity for two cells is shown. AM_1 terrestrial sunlight illumination is shown. Also shown are the spectral outputs of the tungsten iodide,

copper sulphate-water filtered simulator calibrated to AM1, and filtered high pressure xenon simulated in use. A histogram is shown of the current ratios (Xe: W-I) for a number of recent Delaware cells. The I-V characteristics are shown for a cell under various conditions. Results from correcting these measurements to a uniform 100 milliwatts/cm^2 are shown. (MHR)

437 (NASA-TM-X—71802, pp 120-128) **Prediction of terrestrial solar cell short-circuit currents by spectral analysis.** Brandhorst, H.W. Jr. (NASA Lewis Research Center, Cleveland). 1975.

From Terrestrial photovoltaic measurements workshop; Cleveland, Ohio, USA (19 Mar 1975).

In Terrestrial photovoltaic measurements.

The key to predicting solar cell performance is determining the short-circuit current. This current depends on the intensity and spectral distribution of the light source and the spectral response of the solar cell. A group of 31 silicon solar cells was selected for comparing the short-circuit current determined by the filter wheel technique and by natural sunlight measurements. The accuracies (+2 percent) are shown in predicting the currents for four of the five groups of cells measured in this study using the filter wheel technique for the independent prediction of terrestrial solar cell short-circuit techniques. (MHR)

438 (NASA-TM-X—71802, pp 129-133) **Terrestrial solar cell measurements.** Ralph, E.L. (Spectrolab, Inc., Slymar, CA). 1975.

From Terrestrial photovoltaic measurements workshop; Cleveland, Ohio, USA (19 Mar 1975).

In Terrestrial photovoltaic measurements.

Measurement techniques, calibration of standard cells, and performance testing of solar cells are discussed. A typical standard cell output distribution is shown. (MHR)

439 (NASA-TM-X—71802, pp 134-139) **Solar cell measurement techniques used at NASA Lewis Research Center.** Hart, R.E. (NASA Lewis Research Center, Cleveland). 1975.

From Terrestrial photovoltaic measurements workshop; Cleveland, Ohio, USA (19 Mar 1975).

In Terrestrial photovoltaic measurements.

The techniques in use at the Lewis Research Center to obtain accurate measurement of the outer space performance of solar cells are described. The testing procedure evolved uses calibrated solar cells whose spectral response closely matches those of the test cells to set the intensity of an artificial light source. The spectrum of this light source reasonably approximates the spectral distribution of outer space sunlight. Electrical measurement circuitry uses a basic four-wire system. Cell spectral responses are measured using 18 narrow bandpass monochromatic interference filters. (MHR)

440 (NASA-TM-X—71802, pp 146-147) **Results of session I working group: solar intensity and spectrum conditions for terrestrial photovoltaics.** Hickey, J.R. 1975.

From Terrestrial photovoltaic measurements workshop; Cleveland, Ohio, USA (19 Mar 1975).

In Terrestrial photovoltaic measurements.

The following were discussed: which solar curve to employ, which air mass (solar zenith angle) would be most representative, atmospheric models, calculation of cell output, weather data, recommendations of NSF workshop, spectral response data, and units. (MHR)

441 (NASA-TM-X—71802, pp 151-153) **Results of session III working group: methodology for measurement and calibration of solar cells.** Ralph, E.L. 1975.

From Terrestrial photovoltaic measurements workshop; Cleveland, Ohio, USA (19 Mar 1975).

In Terrestrial photovoltaic measurements.

It was realized that an agreement on acceptable measurement methods was needed immediately that could be used over the next year to make accurate measurements of many types of cells at various laboratories across the country. The minimum data that provides sufficient information to intelligently compare cells were agreed upon. The only test that everyone felt was satisfactory for production testing of a wide range of cell types was a filtered xenon light source set up with a standard cell of the type being tested. Measurements in sunlight against a calibrated pyranometer or other thermopile detector were found to be acceptable and accurate for R and D tests but not satisfactory for production due to the limited test times. Some general recommendations are given. (MHR)

442 (NASA-TM-X—71802, pp 154-155) **Unified recommendations of the workshop.** Brandhorst, H. 1975.

From Terrestrial photovoltaic measurements workshop; Cleveland, Ohio, USA (19 Mar 1975).

In Terrestrial photovoltaic measurements.

It was agreed that measurements of solar cell performance in natural sunlight are the most acceptable. A cell temperature of 28.2°C was specified as was a 100 milliwatt per square centimeter intensity for the solar simulator. Short-circuit current is to be measured at less than or equal to a 20-millivolt load, and the impedance of the voltmeter used to obtain open-circuit voltage is to be greater than 10^4 ohms per volt. It was agreed that for theoretical calculations a standard AM2 solar spectral distribution curve should be used. (MHR)

443 (PB—268457) **Silicon Schottky photovoltaic diodes for solar energy conversion. Quarterly progress report 1 Jan 77—31 Mar 77.** Anderson, W.A. May 1977. 23p. (NSF/RANN/SE/AER—73-03197/PR-77/1). NTIS PC A02/MF A01.

The research involves a fivefold plan to achieve 12.5% efficiency and apply the Schottky process to more economical silicon. A study of the interfacial insulating layer is made to correlate layer thickness and composition with solar cell performance. Scanning electron microscope and Auger spectrographic analyses is used with electronic tests to investigate this effect. These results should enable the authors to adjust fill factor by altering processing variables. Processing variables are studied using substrate heating, substrate biasing, and sputtered-top metal layers. The Schottky process is also applied to ribbon silicon and polysilicon to investigate the efficiency as applied to continuous fabrication techniques. Experimental results will be compared to computer-generated data using the model of a solar cell with variable parameters. Environmental tests will continue on existing and new solar cells.

444 (SAN/1202—77/1) **Thin films of gallium arsenide on low-cost substrates. Quarterly project report No. 2, October 3, 1976—January 1, 1977.** Ruth, R.P.; Dapkus, P.D.; Dupuis, R.D.; Campbell, A.G.; Johnson, R.E.; Manasevit, H.M.; Moudy, L.A.; Yang, J.J. Jan 1977. Contract EY-76-C-03-1202. 66p. Dep. NTIS, PC A04/MF A01.

The metallorganic chemical vapor deposition (MO-CVD) technique is being applied to the growth of thin films of GaAs and GaAlAs on inexpensive polycrystalline or amorphous substrate materials (glasses, glass-ceramics, alumina ceramics, and metals) for use in fabrication of large-area low-cost photovoltaic device structures. Trimethylgallium (TMG), arsine (AsH_3), and trimethylaluminum (TMA) are mixed in appropriate concentrations at room temperature in the gaseous state and pyrolyzed at the substrate, which is heated in a vertical reactor chamber to temperatures in the range 600 to 800°C, to produce the desired film composition and properties. The effects of H_2 and AsH_3 atmospheres at temperatures of 625 to 725°C and the effects of several different cleaning procedures on the surfaces of candidate substrates have been investigated. Composite substrates, consisting of deposited Mo layers on several of the other substrate materials, and deliberately textured glass surfaces have been evaluated for GaAs film growth. Efforts have continued to acquire new or improved materials from various manufacturers for evaluation as possible substrates. A new dedicated reactor system was completed during the quarter and used for growth of undoped GaAs films on single-crystal substrates, to establish and characterize reactor performance, and for growth of Se-doped GaAs films on single-crystal substrates, to establish the n-type doping capabilities of the new reactor. The majority of the MO-CVD experiments, however, have involved the reactor system in use since the program began, and include growth of GaAlAs on single-crystal substrates; growth of polycrystalline GaAs on candidate low-cost substrates; and studies of the nucleation of GaAs on low-cost substrates. Results of these experiments are discussed in detail.

445 (SAND—76-7006) **Investigation of terrestrial photovoltaic power systems with sunlight concentration.** Aug 1977. Contract EY-76-C-04-0789-03-9040. 152p. Dep. NTIS, PC A08/MF A01.

A major Spectrolab task was to recommend a concentrator system that appears best suited for development into a 10 kW prototype. This task resulted in the recommendation of a 2 axis tracking concentrator system using passive cooling. The optics of this system consisted of reflective parabolic troughs, each operating in conjunction with a second stage compound elliptical secondary mirror. A review of the work leading to this recommendation is given. Other program tasks included continuation of experimental work in both the concentrator systems and device area. They included a 2 axis tracking platform equipped with an on-axis fresnel lens system, a non-tracking low concentration system, and a flat array. Solar insolation data, both total and direct along with other important weather data was monitored as necessary during this period. A review of these experiments and their results are given. In the device design area a low level but effective effort was directed at upgrading concentrator cell efficiency. The results of this effort substantiated earlier predictions that silison solar cells could operate efficiently at 100 AM1 solar constants and higher. This work is also reviewed.

446 (SAND—77-0760C) **Performance, problems, and expectations of concentrator photovoltaic systems.** Burgess, E.L. 1977. Contract EY-76-C-04-0789. 8p. (CONF-770547—1). Dep. NTIS, PC A02/MF A01.

From Solar energy short course; Madrid, Spain (2 May 1977).

The photovoltaic cell or solar cell can be used to convert sunlight directly into electrical energy and its relatively simple construction and absence of moving parts make these devices attractive for terrestrial power generation applications. The primary problem preventing large-scale application is the very high cost of solar cell arrays. For example, the most advanced solar cell is the silicon cell and, currently in the United States, silicon solar arrays cost about $15,000 per peak kilowatt in moderately large quantities. One approach to reducing the cost of solar cell arrays is to concentrate sunlight on the cells and increase the specific output power density of the cells. In this approach, expensive solar cell area is replaced by, hopefully, less expensive reflective or refractive concentrator materials. The United States Energy Research and Development Administration (ERDA) is supporting a program to develop concentrator photovoltaic systems with the primary objective to develop low-cost reliable systems for widespread terrestrial applications. The specific long-term cost goal for these systems is $500 per peak kilowatt by 1982. The most promising solar cell systems for concentrator applications are silicon and galium arsenide and these materials have received the most attention to date in the ERDA program. Design, preliminary performance testing results, and cost estimates for concentrator photovoltaic systems are discussed.

447 High-field effects in photovoltaic cells. Boeer, K.W. (Univ. of Delaware, Newark). pp 22.1-22.4 of In Proceedings of the 1977 annual meeting of the American Section of the International Solar Energy Society. Volume 1, Sections 14—25. Beach, C.; Fordyce, E. (eds.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1977).

From Solar world meeting; Orlando, Florida, USA (6 Jun 1977).

See CONF-770603—P2.

The CdS/Cu_2S heterojunction cell is in several respects well suited to understand the photovoltaic effect in heterojunction solar cells. To the best of our present understanding, it consists of an abrupt junction between a highly p-type Cu_2S layer and a moderately doped CdS; hence it separates two regions with different action, namely the Cu_2S, where most of the light is absorbed and minority carriers are generated and the CdS, where essentially all of the voltage drop occurs. The Cu_2S acts as emitter, the CdS harbors the space charge region, which may be described as modified Schottky barrier. The potential drop in the CdS part of the junction is caused by a barrier layer as the electron density decreases from the semiconducting CdS bulk to the much lower density at the CdS/Cu_2S interface. This electron density at the CdS/Cu_2S interface is the communicating means between the magnitude of the voltage drop in the CdS and the magnitude of the current from the Cu_2S, hence controls the current voltage characteristics. Because of intrinsic doping (Cd surplus) the trap (donor) density is at least of the order of $10^{17}cm^{-3}$ in the range between 0.2 and 0.4eV below the conduction band. With compensation, these traps are depleted. However, with light they are filled again and contribute to the space charge in the junction. Only if the holes generated by light and mostly trapped by sensitizing centers (Cu) can be released, as the trapped electrons are in the junction, could the resulting space charge be limited to a value well below $10^{16}cm^{-3}$. This can indeed be achieved by field quenching. Further evidence is presented which supports the need for such highfield effects to effectively limit the field in the junction to values well below such at which diode leaking would occur.

448 Low cost, high efficiency solar cells using indium—tin oxide on semiconductor (OSOS) solar cells. DuBow, J.B.; Duff, W.S.; Shewchun, J. (Colorado State Univ., Ft. Collins). pp 22.5-22.8 of In Proceedings of the 1977 annual meeting of the American Section of the International Solar Energy Society. Volume 1, Sections 14—25. Beach, C.; Fordyce, E. (eds.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1977).

From Solar world meeting; Orlando, Florida, USA (6 Jun 1977).

See CONF-770603—P2.

Results with Oxide Semiconductor on Silicon (OSOS) solar cells with efficiencies of 12 percent have been reported recently. Such cells are of interest because the method of junction formation is amenable for use with polycrystalline semiconductor films. Polycrystalline films of GaAs or Si, for example, offer a considerable cost improvement over a single crystal material. In addition to forming an induced p-n junction at the surface of the semiconductor, the oxide semiconductor film acts as a transparent window which lets solar radiation into the junction for collection, as a front ohmic contact layer to the cell since it is a degenerate semiconductor (highly conducting), and as an antireflection coating for the device. The oxide semiconductor (Indium-Tin Oxide, for example) can be applied in layers of a few thousand angstroms thick, and this helps passivate the surface against the ambient. Experimental results are presented showing how the device is fabricated along with a theoretical model for its operation. It is shown that a structure of this type can meet the cost goals set by ERDA for solar photovoltaics.

449 Use of silicone gel for potting photovoltaic arrays. Sierawski, D.A.; Currin, C.G. (Dow Corning Corp., Midland, MI). pp 22.14-22.17 of In Proceedings of the 1977 annual meeting of the American Section of the International Solar Energy Society. Volume 1, Sections 14—25. Beach, C.; Fordyce, E. (eds.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1977).

From Solar world meeting; Orlando, Florida, USA (6 Jun 1977).

See CONF-770603—P2.

The suitability of silicone gel for protecting solar cells in photovoltaic arrays is described. A silicone gel because of its soft nature will provide stress relief to the cells and interconnects. Because of its excellent adhesion a silicone gel will afford corrosion protection to the cells. This relation of adhesion and corrosion protection is explored.

450 Characteristics of solar cells designed for concentrator systems. O'Donnell, D.T.; Harmon, S.Y.; Robb, S.P.; Backus, C.E.; Jacobson, D.L. (Arizona State Univ., Tempe). pp 23.1-23.5 of In Proceedings of the 1977 annual meeting of the American Section of the International Solar Energy Society. Volume 1, Sections 14—25. Beach, C.; Fordyce, E. (eds.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1977).

From Solar world meeting; Orlando, Florida, USA (6 Jun 1977).

See CONF-770603—P2.

There are several organizations that are presently making solar cells that are especially designed for use in concentration systems. Although these cells are still experimental in their development thus far, they have shown that cells can be designed that maintain their performance parameters, such as efficiency, under very high concentration levels. It is expected that further development will show that silicon cells will be able to operate at normal efficiencies at over 100 suns of concentration and that GaAs will be able to operate at over 2000 suns. The efficiencies decrease approximately in a linear manner with increased temperature and thus any system that would combine electrical and thermal outputs would require a trade-off analysis that would depend on the electrical and thermal demands of the application.

451 Residential photovoltaic prototype system definition study. Imamura, M.S.; Sanders, J.A. (Martin Marietta Corp., Denver). pp 23.6-23.10 of In Proceedings of the 1977 annual meeting of the American Section of the International Solar Energy Society. Volume 1, Sections 14—25. Beach, C.; Fordyce, E. (eds.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1977).

From Solar world meeting; Orlando, Florida, USA (6 Jun 1977).

See CONF-770603—P2.

The main effort was directed at the parametric sensitivity study and definition of the conceptual design. A computer program containing the solar irradiance, solar array, and energy balance models was developed. Using this program, analyses were conducted to determine the sensitivities of solar insolation and the corresponding solar array output at five sites selected for this study as well as the performance of several solar array/battery systems. Based on the results of this analysis, a baseline electrical configuration was chosen and three design options were recommended. Architectural renderings of two photovoltaic residential concepts, one above-ground and the other underground, are also presented.

452 Experimental investigation of a solar cell/inverter system. Eltimsahy, A.H.; DeLombard, R. (Univ. of Toledo). pp 23.11-23.15 of In Proceedings of the 1977 annual meeting of the American Section of the International Solar Energy Society. Volume 1, Sections 14—25. Beach, C.; Fordyce, E. (eds.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1977).

From Solar world meeting; Orlando, Florida, USA (6 Jun 1977).

See CONF-770603—P2.

Experimental results of the investigation of the performance of a solar cell/inverter system (SCI) used for coupling to a conventional three-phase power network are presented. Using the mathematical model for silicon solar cells and a programmable power supply, a simulator is designed and built that allows the variation of the solar cell array size. This simulator is driven by an actual small solar cell array (reference array). The cells are then coupled to the network by means of a three phase 6 pulse silicon controlled rectifier bridge inverter similar to those used in d.c. transmission lines. Experimental studies of the steady state performance show that successful operation is possible when the solar cells are used under constant voltage and maximum power. Sample results of waveforms under successful operation are investigated. The proposed SCI system is shown experimentally to deliver over 80% of the optimal solar cell array power to the electric network. If solar cell arrays ever become economically feasible, direct conversion of the array energy to a.c. power is the most likely approach to their utilization.

453 Dye sensitization of Schottky barrier solar cells. Skotheim, T. (Univ. of California, Berkeley). pp 23.16-23.19 of In Proceedings of the 1977 annual meeting of the American Section of the International Solar Energy Society. Volume 1, Sections 14—25. Beach, C.; Fordyce, E. (eds.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1977).

From Solar world meeting; Orlando, Florida, USA (6 Jun 1977).

See CONF-770603—P2.

A new kind of solar cell has been made in which an organic dye is incorporated into the junction region of a Schottky barrier device consisting of Au on TiO_2. The performance of two different devices are compared: one with approximately ten monolayers of a thiacarbocyanine dye between the semiconductor substrate and the transparent metal overlayer, and one with a semitransparent layer of hydroquinone between the dye layer and the metal. It is found that a thin layer of hydroquinone increases the quantum efficiency by more than a factor of ten to about 1% at the peak of absorption.

454 Application of color response data of silicon cells for improving photovoltaic efficiency. Ertel, D. (Univ. of Miami, Coral Gables, FL). pp 23.20-23.24 of In Proceedings of the 1977 annual meeting of the American Section of the International Solar Energy Society. Volume 1, Sections 14—25. Beach, C.; Fordyce, E. (eds.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1977).

From Solar world meeting; Orlando, Florida, USA (6 Jun 1977).

See CONF-770603—P2.

The ultimate desirability of any energy production process is maximum conversion efficiency. The photovoltaic efficiency of silicon solar cells is considered, with specific consideration given to major physical constraints, those not due to cost, production efficiency or purity. These seemingly unavoidable constraints are basically inherent chemical properties of the semiconductor silicon. In order to pull an electron loose from its bondpair in a silicon crystal, and thus generate a current, 1.08 electron-volts of energy must be expended at room temperature. An analysis of the various wavelengths of light (designated by their various color bands), whose photons possess the appropriate energy level, is a key to improving photovoltaic efficiency. This information can then be used to maximize efficiency by eliminating ineffective bands of light and concentrating the rest.

455 Estimated cost of electricity produced by four types of compound parabolic concentrators. Cole, R.; Gorski, A.; McIntire, W.; Schertz, W.; Winston, R. (Argonne National Lab., IL). pp 23.25-23.30 of In Proceedings of the 1977 annual meeting of the American Section of the International Solar Energy Society. Volume 1, Sections 14—25. Beach, C.; Fordyce, E. (eds.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1977).

From Solar world meeting; Orlando, Florida, USA (6 Jun 1977).

See CONF-770603—P2.

The costs of electricity created by a photovoltaic panel of Compound Parabolic Concentrators (CPCs) are estimated in this work for four types of CPCs. The cost estimates are related, where possible, to detailed analyses performed by others, but where that is not possible, cost estimates are based on material costs with allowances for fabrication in large quantities. Numerical results indicate that the lowest costs would be achieved by a DCPC cone with crude two-axis tracking. The DCPC cone achieves its estimated low cost primarily by (1) the high optical efficiency of the concentrator and (2) its ability to use crude two-axis tracking. The DCPC and HCPC troughs can also achieve significant cost reductions compared to the cost of unconcentrated solar panels. The main advantages of the CPC troughs are that only seasonal adjustment of the panel is required to track the sun, and the alignment of individual modules on the support structure is less critical than for a focusing system.

THERMIONIC AND THERMOELECTRIC CONVERSION

456 (NASA-TM-X—71802, pp 140-145) **Standard for solar cell testing and reporting.** Meakin, J.D. (Univ. of Delaware, Newark). 1975.

From Terrestrial photovoltaic measurements workshop; Cleveland, Ohio, USA (19 Mar 1975).

In Terrestrial photovoltaic measurements.

In order that meaningful comparisons can be made between different types of cells and between cells of different producers, it is essential that standardized solar simulation and cell testing be established. Here, an attempt is made to lay the groundwork for the meaningful and reliable testing and reporting of solar cell performance. (MHR)

BIOMASS PRODUCTION AND CONVERSION

457 (COO—3162-32) **Annual progress report, September 1, 1975—August 31, 1976.** Clayton, R.K. 1976. Contract E(11-1)-3162. 11p. Dep. NTIS $3.50.

Measurements of the quantum efficiencies of photochemistry and fluorescence, in photosynthetic reaction centers from Rhodopseudomonas sphaeroides, have been extended to low temperatures. Studies of linear dichroism in oriented fragments of photosynthetic membranes have revealed the orientations of bacteriochlorophyll and other pigments, both in the "antenna" and in the reaction centers. New measurements of absorbance changes associated with reduced components in reaction centers will hopefully allow one to trace the movement of electrons from primary to secondary acceptors. An attempt is being made to use these materials in the construction of a solar battery. The spectrum and quantum efficiency of fluorescence from bacteriorhodopsin was measured.

458 (ERDA/USN/1027—76/1(Vol.1)) **Ocean food and energy farm project. Subtask No. 6: systems analysis. Volume 1. Overall economic analysis of the base line design. Final report.** Budhraja, V.S.; Anderson, B.N.; Hoffman, G.A.; Nickels, F.J.; Schneider, R.H.; Walsh, D.H. Jul 1976. Contract E(49-26)-1027. 89p. Dep. NTIS, PC A05/MF A01.

The Ocean Food and Energy Farm (OFEF) concept involves utilizing the energy from the sun and the nutrients residing in the oceans in large scale farming of the oceans to grow kelp (Macrocystis pyrifera) and marine animals. The initial systems analysis of the Ocean Food and Energy Farm is reported. A preliminary evaluation of the economic and technological feasibility of the concept is presented. Data and information needed for formulating an effective research and development strategy are also presented.

459 (ERDA/USN/1027—76/1(Vol.3)) **Ocean Food and Energy Farm project. Subtask No. 6: systems analysis. Volume 3. The harveting subsystem. Final report.** Nickels, F.J. Jul 1976. Contract E(49-26)1027. 102p. Dep. NTIS, PC A06/MF A01.

The primary functions of the kelp harvesting subsystem, as considered in this analysis, are to cut the mature kelp fronds, collect the cut kelp from the water, provide power to pretreat the kelp and store the pretreated kelp, and deliver the pretreated kelp to the offshore unloading terminal. There are many possible harvesting subsystem configurations which could perform the above functions. As a result of a preliminary screening of a variety of potential configurations, three basic subsystem concepts were identified as worthy of first level analysis. These were designated Concepts A, B, and E. Because of project resource limitations, the design decision and economic analysis were only performed for Concept A. This concept involves a fleet of vessels, each of which performs the complete set of harvesting subsystem functions.

460 (ERDA/USN/1027—76/1(Vol.4)) **Ocean food and energy farm project. Subtask No. 6: systems analysis. Volume 4. Processing subsystem. Final report.** Hoffman, G.A.; Budhraja, V. Jul 1976. Contract E(49-26)-1027. 94p. Dep. NTIS, PC A05/MF A01.

The processing subsystem of the Ocean Food and Energy Farm (OFEF) performs the functions related to conversion of the kelp harvest into synthetic natural gas and valuable by-products. It consists of seven major processes: pretreatment to wash and chop harvest; pressing to separate volatile solids from salts; filtration to recover soluble carbohydrates from salt (brine) solution; brine processing to recover fertilizer salts and water from brine solution; anaerobic digestion to convert volatile material into gases and sludges; sludge processing to convert sludges into fertilizer or feed for mariculture; gas compression and scrubbing to remove carbon dioxide and enter synthetic natural gas into gas transmission pipelines. The systems and economic analysis of the processing subsystem is presented. The approach was to define a base line design for economic analysis, based on a review of the state-of-the-art, discussions with program management, and consultation with advisors and experts in the field. The resulting design is by no means an optimized or recommended design but a representative one suitable for estimating overall costs and productivity, and for identifying opportunities for design trade-off studies and areas of cost sensitivity.

461 (ERDA/USN/1027—76/1(Vol.5)) **Ocean food and energy farm project. Subtask No. 6: systems analysis. Volume 5. Support subsystem. Final report.** Budhraja, V.S. Jul 1976. Contract E(49-26)-1027. 47p. Dep. NTIS, PC A03/MF A01.

The support subsystem of the Ocean Food and Energy Farm (OFEF) handles the activities and functions which are not unique to any particular subsystem. It provides support in terms of men, materials, equipment, life support, inspection, repairs, and other items which cross subsystem boundary lines, and where functions can be performed more efficiently and cost effectively when handled in a centralized fashion. For the base line design, a 300 feet by 300 feet barge-type platform was selected. The deck space is devoted to life support, storage and warehouse, machine shop, dock facilities, helipad, communications and control, and propulsion and power

unit. The platform is designed to house up to 50 people. The platform will be positioned in close proximity to the farm, though it will operate independently. It is concluded that the base line design is technologically and economically feasible.

462 Hydrogen from sunlight: the biological answer. Development of a low-cost biological solar panel. Friedland, J. (Dade County Public Schools, FL). pp 25.1-25.5 of In Proceedings of the 1977 annual meeting of the American Section of the International Solar Energy Society. Volume 1, Sections 14—25. Beach, C.; Fordyce, E. (eds.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1977).

From Solar world meeting; Orlando, Florida, USA (6 Jun 1977).

See CONF-770603—P2.

By using several systems which have proven effective in the past, a basic biological solar panel was created. Apparatus was constructed to test various phases. First, previously tested hydrogen-producing photosynthetic organisms (from trace amounts to high yields), and optimum environmental conditions were used in the development of the biological phase. Researchers have indicated that the most promising organism, a marine, blue-green algae (Miami BG 7), produced one ml of hydrogen for one ml of algae over a period of 24 hours. Next, a series of thin polymer membranes, previously tested only by qualitative methods, were tested quantitatively. An apparatus was devised to test these membranes: poly(vinylidene chloride) "saran," polyethylene "Glad-Wrap," and polyethylene terephthalate "mylar," with several gases, including oxygen, nitrogen (as air), argon, and hydrogen, to determine their selective semi-permeability, and to determine which would allow only the transmission of hydrogen. The most optimum membrane, "saran," allowed less than 1% of the oxygen, nitrogen, or argon to pass, while permitting transmission of over 90% of the hydrogen. These two phases were then combined to create the third phase, the first level in the development of a biological solar panel, potentially providing a new alternative to help the nation's need for clean, nonpolluting energy.

463 Solar energy conversion with microalgal sewage treatment ponds. Benemann, J.R.; Koopman, B.L.; Weissman, J.C.; Oswald, W.J. (Univ. of California, Berkeley). pp 25.6-25.10 of In Proceedings of the 1977 annual meeting of the American Section of the International Solar Energy Society. Volume 1, Sections 14—25. Beach, C.; Fordyce, E. (eds.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1977).

From Solar world meeting; Orlando, Florida, USA (6 Jun 1977).

See CONF-770603—P2.

The microalgal biomass produced in oxidation ponds represents a potential source of methane and fertilizers obtainable through harvesting and anaerobic digestion of the microalgae. Harvesting is presently the limiting technical problem because of the small size and diversity of microalgae present in the oxidation ponds. This limitation could be overcome if oxidation pond operations could be developed which would result in microalgal populations consisting of filamentous or large colonial algal species. These can be readily and economically harvested by "microstrainers"--slowly rotating fine mesh screens stretched over drums and equipped with a backwash. One algal species control technique, demonstrated in both laboratory and outdoor experiments, is the recycling to the ponds of part of the harvested algal biomass. Results obtained demonstrate that this technique helps to establish and maintain the desirable, harvestable algal species in the ponds. Another technique that could be applied to oxidation ponds is the selective cultivation of nitrogen-fixing blue-green algae in ponds. Since sufficient phosphate is available in most sewage to make it the ultimate limiting nutrient, nitrogen-limiting conditions (which favor the nitrogen-fixing blue-green algae) could be established through carbon dioxide enrichment of sewage. In practice, algal species control must be achieved through adjustment in pond operations (depth, detention times, loadings, mixing, pH, etc.) which are economically feasible. Integrated algal biomass production-sewage treatment systems could provide substantial amounts of substrate natural gas and fertilizer, while at the same time solving a significant environmental problem.

464 Photosynthetic and water efficiency of Salsola pestifer. Meinel, A.B.; Meinel, M.P. (Univ. of Arizona, Tucson). pp 25.11-25.13 of In Proceedings of the 1977 annual meeting of the American Section of the International Solar Energy Society. Volume 1, Sections 14—25. Beach, C.; Fordyce, E. (eds.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1977).

From Solar world meeting; Orlando, Florida, USA (6 Jun 1977).

See CONF-770603—P2.

Salsola pestifer (tumbleweed) has a photosynthetic efficiency of 0.5% but is the most efficient plant for water use efficiency. The plant grows over a wide area of the western United States as a weed. Measured yields in metric tons per acre offer a crop requiring minimum care yielding $320/acre. Direct combustion of the pelletized plant is proposed.

PHOTOCHEMICAL CONVERSION

REFER ALSO TO CITATION(S) 457

PHOTOVOLTAIC POWER PLANTS

REFER ALSO TO CITATION(S) 452

465 Solar photovoltaic power stations. Chowaniec, C.R. (Westinghouse Electric Corp., East Pittsburgh, PA); Ferber, R.R.; Pittman, P.F.; Marshall, B.W. pp 22.9-22.13 of In Proceedings of the 1977 annual meeting of the American Section of the International Solar Energy Society. Volume 1, Sections 14—25. Beach, C.; Fordyce, E. (eds.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1977).

From Solar world meeting; Orlando, Florida, USA (6 Jun 1977).

See CONF-770603—P2.

There are several major cost elements in addition to solar cells which must be included in the cost of a solar photovoltaic power station. The subsystems are identified and the cost of major components is estimated. From these, cost/performance tradeoffs can be made. The capital and energy costs for a solar photovoltaic power station are then determined.

SOLAR THERMAL POWER PLANTS

REFER ALSO TO CITATION(S) 571

466 (NP—22032) **Satellite solar power.** O'Neill, G. 5 Mar 1976. 44p. Energy Resources Conservation and Development Commission, Sacramento.

The feasibility and status of orbital solar thermal power plants is reviewed. Microwave power transmission and the possibility of constructing the power plant using lunar materials are discussed. Economics and other aspects are considered. (WHK)

CENTRAL RECEIVER

467 (EPRI-ER—403-SU) **Closed cycle high-temperature central receiver concept for solar electric power.** Aug 1976. 52p. Dep. NTIS, PC A04/MF A01.

The Electric Power Research Institute (EPRI) awarded Boeing a contract to examine the technical feasibility of a high temperature, gas cooled central receiver for producing electric power from solar energy using a closed Brayton helium cycle. Feasibility was examined in terms of system life, efficiency, cost, and technology requirements. These considerations have been implemented into the conceptual design of a receiver for utilization in a 100 megawatt output solar plant. The rationale is provided which supports the configuration, equipment arrangement, and material choices. Thermal cycling tests simulating a 30-year lifetime of the receiver's heat exchangers at operational temperatures to 816°C (1500°F) were performed to select materials. Preliminary design considerations were made for a 1 megawatt bench model receiver to verify the full scale receiver. Preliminary planning was developed for a 10 megawatt electrical pilot plant to follow the receiver verification. The scope of the study also included system/subsystem definition for employing the central receiver design in a solar plant and predicting plant performance. Conceptual designs of several thermal energy storage devices were defined, integrated into plant performance and operational models, and evaluated with energy cost as the criteria. The information developed during the study is highlighted in this final summary report.

468 Promising results from A.N.U. solar ammonia system. 4: No. 3, 12-15(Mar 1977).

The solar ammonia system has potential as an alternative, rather than a supplement, to fossil fuels. The essential elements of the system are a system of paraboloidal mirrors which track the Sun. Solar energy is reflected to the focal points of the mirrors. At the focal point, a focal absorber dissociates ammonia under high pressure into a mixture of nitrogen and hydrogen at about 700 C. This mixture is then piped under high pressure in small diameter pipes to a central station where solar energy is recovered as heat by reversal of the chemical change in a synthesizer using an alumina/nickel catalyst. The heat energy output may then be used for steam to generate electricity or as high temperature heat for other processes. Alternatively the nitrogen/hydrogen mixture may be stored for later reconversion. The system uses a heat exchanger in conjunction with the focal absorber to pre-heat incoming ammonia and cool the

outflowing gas mixture. The system operates as a closed loop with the nitrogen and hydrogen reactants recirculating as ammonia. Cost calculations show that electricity produced by the system can now be competitive with electricity produced from present fuels. The minimum viable plant size is about 10 million watts, applicable to a remote township. (MCW)

469 Analysis of closed cycle Brayton systems for solar electric power generation. Gintz, J.R.; Vieth, G.L. (Boeing Engineering and Construction, Seattle). pp 20.20-20.24 of In Proceedings of the 1977 annual meeting of the American Section of the International Solar Energy Society. Volume 1, Sections 14—25. Beach, C.; Fordyce, E. (eds.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1977).

From Solar world meeting; Orlando, Florida, USA (6 Jun 1977).

See CONF-770603—P2.

A performance and cost analysis of three Brayton-type gas cycles was done for a high temperature/central receiver solar power plant. The three cycles were closed cycle helium and open and closed cycle air. These analyses are an important inclusion in solar power plant studies because of the direct effect cycle efficiency has on heliostat costs, with these costs typically estimated to be on the order of 50% of the plant costs.

470 Liquid sodium cooled solar tower system. Vant-Hull, L.L. (Univ. of Houston, TX). pp 20.25-20.29 of In Proceedings of the 1977 annual meeting of the American Section of the International Solar Energy Society. Volume 1, Sections 14—25. Beach, C.; Fordyce, E. (eds.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1977).

From Solar world meeting; Orlando, Florida, USA (6 Jun 1977).

See CONF-770603—P2.

A low pressure liquid sodium cooled central receiver system is described. The high thermal conductivity of liquid metals leads to a more compact and efficient receiver while the generation of turbine steam from hot stored sodium decouples the turbine from the receiver and leads to very efficient trouble free operation. Safety and economics of the sodium system are comparable to a water steam system with hot oil and rocks thermal storage.

471 Results of experiments with heliostats for central receiver power plants. Thornton, J.P.; Waddington, D. (Martin Marietta Corp., Denver). pp 21.1-21.6 of In Proceedings of the 1977 annual meeting of the American Section of the International Solar Energy Society. Volume 1, Sections 14—25. Beach, C.; Fordyce, E. (eds.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1977).

From Solar world meeting; Orlando, Florida, USA (6 Jun 1977).

See CONF-770603—P2.

Two new applications of standard techniques are providing more accurate measurements of heliostat performance over longer ranges than have ever before been achieved. Four experimental heliostats have been fabricated and installed in the Solar Thermal Test Facility at Martin Marietta, Denver. Performance testing of these heliostats has been completed, and the resulting data are being used in support of the design of commercial central receiver solar power plants. Both the design of the experimental heliostats and the results of the performance testing are described.

472 Subsystem research experiments on a central receiver collector. Easton, C.R.; Blackmon, J.B.; McCormick, R.E. (McDonnell Douglas Astronautics Co., Huntington Beach, CA). pp 21.7-21.10 of In Proceedings of the 1977 annual meeting of the American Section of the International Solar Energy Society. Volume 1, Sections 14—25. Beach, C.; Fordyce, E. (eds.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1977).

From Solar world meeting; Orlando, Florida, USA (6 Jun 1977).

See CONF-770603—P2.

McDonnell Douglas Astronautics Company has just completed a series of tests on representative hardware for the collector subsystem of a central receiver solar thermal power plant. These tests comprised a portion of the preliminary design of a central receiver system under contract to the Energy Research and Development Administration (ERDA). Summary descriptions of these tests and key results are presented.

473 Analytic evaluation of the flux density due to sunlight reflected from a flat mirror having a polygonal boundary. Lipps, F.W.; Walzel, M.D. (Univ. of Houston, TX). pp 21.11-21.14 of In Proceedings of the 1977 annual meeting of the American Section of the International Solar Energy Society. Volume 1, Sections 14—25. Beach, C.; Fordyce, E. (eds.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1977).

From Solar world meeting; Orlando, Florida, USA (6 Jun 1977).

See CONF-770603—P2.

Computer algorithms for the flux density of reflected sunlight from a heliostat became an essential part of the optical simulation problem for the solar central receiver system. An exact analytic result is available for heliostats having polygonal boundaries. A comparison is made between the analytic method and the Hermite function method, which is much faster but less accurate. The analytic method provides a basis for evaluating all other flux density calculations.

474 One MW/sub th/ solar cavity steam generator solar test program. Tracey, T.R. (Martin Marietta, Denver); Blake, F.A.; Royere, C.; Brown, C.T. pp 21.15-21.20 of In Proceedings of the 1977 annual meeting of the American Section of the International Solar Energy Society. Volume 1, Sections 14—25. Beach, C.; Fordyce, E. (eds.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1977).

From Solar world meeting; Orlando, Florida, USA (6 Jun 1977).

See CONF-770603—P2.

In order to advance steam generator development as rapidly as possible, an international cooperative research program between the United States (ERDA*) and France (CNRS**) was initiated in 1974 and formalized in 1976. A key feature of the program was the testing of a U.S. built cavity type solar steam generator in the French solar furnace located in Odeillo. This is the largest solar test facility in the world. Martin Marietta Corp. and Georgia Institute of Technology performed the design and fabrication of the receiver, support equipment, optical adaption flux redirector, instrumentation, and water treatment system taken to France for the solar test. The solar test program was conducted between June and August of 1976. The test apparatus, procedures, and results are discussed.

475 Cellwise method for the optimization of large central receiver systems. Lipps, F.W.; Vant-Hull, L.L. (Univ. of Houston, TX). pp 21.21-21.25 of In Proceedings of the 1977 annual meeting of the American Section of the International Solar Energy Society. Volume 1, Sections 14—25. Beach, C.; Fordyce, E. (eds.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1977).

From Solar world meeting; Orlando, Florida, USA (6 Jun 1977).

See CONF-770603—P2.

The total number of heliostats in the collector field determines the approach to the optical simulation problem. For large central receiver systems it is desirable to introduce a cell model which establishes an array of representative heliostats. There is now an arsenal of computer programs which allows one to optimize the arrangement of heliostats in the collector field subject to the approximations of the cell model. Each cell contains an arbitrary regular two dimensional array of heliostats.

476 Baseline design of commercial central receiver solar power plant. Blake, F.A. (Martin Marietta Corp., Denver). pp 21.31-21.35 of In Proceedings of the 1977 annual meeting of the American Section of the International Solar Energy Society. Volume 1, Sections 14—25. Beach, C.; Fordyce, E. (eds.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1977).

From Solar world meeting; Orlando, Florida, USA (6 Jun 1977).

See CONF-770603—P2.

Establishing the technical feasibility and defining the economics of a solar thermal power plant of the "Central Receiver" type with significant commercial potential is the objective of the ERDA sponsored Phase I program nearing completion. The baseline designs of the Martin Marietta, Bechtel, Foster-Wheeler, and Georgia Tech team for the commercial plant and the pilot plant are described. The commercial plant with a rated output of 150 MWe during sunlight operation and an output of 105 MWe from storage consists of fifteen solar collector modules, a thermal storage field and an electrical power generation unit. Each of the collector modules feature 1718 focusing heliostats which focus sunlight into tower mounted cavity receiver steam generators. Basic technical characteristics of the solar plant designs and the current subsystem research experiments being performed to substantiate the design approach are discussed.

477 Sandia studies for ERDA central receiver thermal electric power project. Eicker, P.J.; Brune, J.M. (Sandia Labs., Livermore, CA). pp 632-635 of In Modeling and simulation. Volume 7, Part 1. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P1.

Planning is underway for a 100-megawatt electric demonstration plant to be constructed and on-line by 1985. The objective of this plant is to gain better understanding of the economics of large solar central electric plants. Although still in the planning stages, a

general description of the plant is given. An array of high-quality mirrors (whose total surface area is on the order of 1 km^2) will focus the solar energy on a centrally located tower several hundred meters high. An energy receiver at the top of the tower will use the incident solar energy to convert high-pressure liquid water to superheated steam. Two options are available for the steam; one is immediate generation of power in a steam turbine/generator set; the other is storage of the energy in the steam for use at a later time. The energy storage system is undefined but may be as simple as storage of a hot oil. It is planned that enough energy will be stored to provide electric energy during times of full or partial insolation outage.

478 Conceptual heliostat field design for the ERDA 5-MW Solar Thermal Test Facility at Sandia Albuquerque. Curtner, K.L. (Honeywell Energy Resources Center, Minneapolis); Fourakis, E.M.; Mitchell, P.D. pp 636-640 of In Modeling and simulation. Volume 7, Part 1. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P1.

The working heliostat field for the facility was designed to meet the solar thermal power requirements for testing 4 different receiver subsystem research experiments. Requirements for the field were specified in terms of yearly solar thermal energy available from the heliostats and instantaneous power levels delivered by the heliostat field to the experiments. A ray-trace simulation model of the subsystem research experiment receivers and heliostat field was the principal tool used in this conceptual design. Field deployment, focusing strategy, number of heliostats and total mirror area required to accomplish the test objectives of the facility were established.

479 Modeling aspects of a gas turbine solar-electric power system. McBride, E.J. (Black and Veatch Consulting Engineers, Kansas City, MO); Mitchell, P.D. pp 641-645 of In Modeling and simulation. Volume 7, Part 1. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P1.

In the conceptual design of a high-temperature solar electric plant, two mathematical models and associated computer software have been developed and extensively used. These models are (1) Solar Central Receiver Model. This model analyzes the performance of various combinations of collector field and central receiver geometries in terms of gross power received and power flux maps on the receiver walls. The software is a Monte Carlo ray-trace. (2) Heat Exchanger and Cavity Analysis. This model evaluates the microscopic performances of the heat transfer surfaces and uses the results to evaluate the macroscopic performance of the receiver cavity as a whole.

DISTRIBUTED COLLECTOR

480 Fixed mirror/distributed focus solar thermal electric power systems development. Walters, R.R.; O'Neill, M.J.; Gupta, Y.P. (E-Systems, Inc., Dallas). pp 21.26-21.30 of In Proceedings of the 1977 annual meeting of the American Section of the International Solar Energy Society. Volume 1, Sections 14—25. Beach, C.; Fordyce, E. (eds.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1977).

From Solar world meeting; Orlando, Florida, USA (6 Jun 1977).

See CONF-770603—P2.

The current developments in the overall design, performance and cost analyses of a solar thermal power system concept which uses large fixed spherical mirror segments for the concentrator are presented. This concept is referred to here as the Fixed Mirror/Distributed Focus Solar Thermal Electric Power System (FMDF-STEPS) where a large multi-megawatt power facility would use an array of FMDF collector modules. Results of optical, thermal, structural and economic studies utilizing detailed computer modeling of the FMDF-STEPS are presented along with cost/performance data in terms of dollars per kilowatt of installed costs. These data are compared with that for other solar system concepts currently under consideration by the Energy Research and Development Administration (ERDA).

TOTAL ENERGY AND HYBRID SYSTEMS

REFER ALSO TO CITATION(S) 528

481 Solar hybrid repowering. Groves, D.J. (Public Service Co. of New Mexico, Albuquerque); Maddox, J.D.; Parker, W.G.; Lang, W.R. pp 24.1-24.5 of In Proceedings of the 1977 annual meeting of the American Section of the International Solar Energy Society. Volume 1, Sections 14—25. Beach, C.; Fordyce, E. (eds.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1977).

From Solar world meeting; Orlando, Florida, USA (6 Jun 1977).

See CONF-770603—P2.

A study was completed to assess the engineering and economic feasibility of solar hybrid repowering. An existing gas- and oil-fired steam generation unit appears to be a good demonstration candidate. A parametric economic analysis was performed based on a typical 22 MWe unit. This included the addition of central receiver hardware to displace 100 percent of the fossil boiler firing at winter solstice, with fuel oil backup for demand periods of inclement weather or nighttime operation. The most favorable results indicate solar repowering might save $18 million over a 30-year life versus operation of this intermediate load station on fuel oil only. Additionally, a survey was made of potential candidate plants in the Southwest which will require repowering or replacement within the next 25 years. Six hundred units smaller than 200 MWe capacity, totaling 40,000 MWe, were identified.

482 Design options in solar total energy systems. Hoffman, A.A.J. (Texas Christian Univ., Ft. Worth); Rapp, D. pp 24.16-24.19 of In Proceedings of the 1977 annual meeting of the American Section of the International Solar Energy Society. Volume 1, Sections 14—25. Beach, C.; Fordyce, E. (eds.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1977).

From Solar world meeting; Orlando, Florida, USA (6 Jun 1977).

See CONF-770603—P2.

A solar total energy system consists of a collector field which converts solar radiation to thermal energy in a working fluid which in turn drives a heat engine. Shaft power from this engine drives a mechanical electrical generator while exhaust from the heat engine is used for such applications as space heating, domestic hot water, and process heat. Cooling can be accomplished by electrically driven compression chillers or thermally driven absorption chillers. A multitude of subsystem options and their effects on the overall system are discussed. Such options include choices of type of concentrator, reflecting surfaces, tracking method, alignment (i.e., EW vs. NS), working fluid, temperature, receiver, field size, storage (arrangement, type, capacity), heat engine capacity and type (steam or organic Rankine), heat exchangers, controls, and methods of cooling (compression and absorption). Based on the experience of the authors, the implications of these options on the efficiency, economy, and safety of the system are discussed.

OCEAN THERMAL GRADIENT POWER PLANTS

483 (BNWL-SA—6208) OTEC Bifouling and Corrosion Program. Perrigo, L.D.; Jensen, G.A. Mar 1977. Contract EY-76-C-06-1830. 21p. (CONF-770331—4). Dep. NTIS, PC A02/MF A01.

From 4. ocean thermal energy conversion conference; New Orleans, Louisiana, United States of America (USA) (22 Mar 1977).

The Energy Research and Development Administration (ERDA) is sponsoring a program to explore the possibilities for beneficially using the temperature difference between warm surface water of the tropical oceans and the deeper colder water to operate a heat engine. One of the major technical hurdles that must be crossed to bring this source of energy into commercial use is the solution to biofouling, corrosion and deposition reactions that are expected to reduce heat transfer efficiency. In January 1976, ERDA established a project activity office at Battelle-Northwest whose mission it is to develop, procure, monitor and evaluate projects to define, prevent and/or alleviate biofouling and corrosion problems expected in OTEC power plants. Since startup, this project activity office has developed a methodology to guide work, assumed responsibility or contracted for 10 projects and expects to have several more contractors work on various aspects of biofouling and corrosion problems in the near future. The priorities for near and intermediate term work are identified and the operation of the Project Activity Office is described.

484 (COO/2641—1) Concurrent studies of enhanced heat transfer and materials for ocean thermal exchangers. Progress report, July 1, 1975—July 31, 1976. Rothfus, R.R. 31 Jul 1976. Contract EY-76-S-02-2641. 45p. Dep. NTIS, PC A03/MF A01.

To demonstrate the enhancement of heat transfer in OTEC exchangers by means of fine, axial flutes on the heat transfer surfaces, experiments have been performed on single internally or externally fluted tubes of 1-inch diameter. Internal flutes provide water-side enhancement of both heat transfer and friction to about the same extent. At moderate water velocities heat transfer coefficients and friction factors are greater than those of the comparable smooth tube by a multiplying factor about equal to the fluted-to-smooth surface area ratio. Area ratios from 1.0 to 1.5 have been tested using two styles of flutes. Flute heights have ranged from 3 to

35 mils, tube lengths from 2 to 8 ft. Heat transfer experiments have been performed on Freon-11 moving in a thin layer under gravity down the outer surface of a smooth tube and of a tube having 26-mil external, axial flutes. Test lengths have averaged 4-½ ft. Enhancement of the local coefficient by 3 to 5 times has been observed during both evaporation and condensation. The effectiveness of the flutes is greatest in the range of laminar-turbulent transition.

485 (TR-EE—76-45) **State variable analysis, control, and feasibility of design of an ocean thermal power plant.** Sigg, J.S.; Heydt, G.T. Dec 1976. 82p. (PCTR—33-76). TIC.

One of the most attractive energy conversion techniques is ocean thermal energy conversion. This process uses the existing temperature difference between the upper and lower layers of the ocean to cause phase changes in a working fluid and thus extract net work. Details of the design of a 24 MWe ocean thermal energy converter are presented. In particular, the following design aspects are emphasized: economic analysis, siting considerations, heat cycle description, heat exchanger design, electrical system design and control of the power plant. A brief summary of the biological impact of the ocean thermal energy converter is also given. The design parameters for this power plant are taken from the island of Tutuila, American Samoa.

486 **Forecast markets, economics, and shipbuilding program for OTEC/industrial plant-ships in tropical oceans.** Francis, E.J. (APL/JHU, Laurel, MD); Seelinger, J. pp 24.28-24.32 of In Proceedings of the 1977 annual meeting of the American Section of the International Solar Energy Society. Volume 1, Sections 14—25. Beach, C.; Fordyce, E. (eds.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1977).

From Solar world meeting; Orlando, Florida, USA (6 Jun 1977).

See CONF-770603—P2.

The unique Applied Physics Laboratory concept for Ocean Thermal Energy Conversion (OTEC) ammonia-producing plant-ships "grazing" the tropical oceans is presented. A tropical Atlantic Ocean grazing pattern provides 43°F (24°C) temperature differential 11 of 12 months, reducing costs through an optimized power cycle. Ammonia produced is shown to be commercially competitive at $96 to 99 per short ton delivered to U.S. ports. 24 to 31 plant-ships are needed for U.S. market share prior to 1990; 7 additional for South Atlantic market. Special needs are highlighted for Brazil and India. It is concluded that it would be imprudent for U.S. and tropical countries not to initiate an OTEC/ammonia program as soon as possible.

SOLAR RADIATION UTILIZATION

SPACE HEATING AND COOLING

REFER ALSO TO CITATION(S) 420, 421, 524, 525, 527, 556, 1039, 1041

487 (CONF-760492—) **Solar energy: fuel and food workshop.** Jensen, M.H. (ed.). 1976. Contract E(49-26)-1016. 262p. Dep. NTIS $9.00.

From The solar energy fuel and food workshop; Tucson, Arizona, United States of America (USA) (5 Apr 1976).

Twenty papers are included. Separate abstracts were prepared for each paper. (MHR)

488 (CONF-760492—, pp 1-4) **ERDA—ARS projects on solar heating and cooling of greenhouses and rural residences.** Bond, T.E. 1976.

From The solar energy fuel and food workshop; Tucson, Arizona, United States of America (USA) (5 Apr 1976).

In Solar energy: fuel and food workshop.

A research program to study the potential of solar energy for part of the fossil fuel requirements in the greenhouse production of flowers, vegetables, and nursery plants is described briefly. The nine projects are listed with the location, Project Manager, and objectives of each. (MHR)

489 (CONF-760492—, pp 9-10) **ARS commitments on energy research in agriculture.** Altman, L. (Agricultural Research Center, Beltsville, MD). 1976.

From The solar energy fuel and food workshop; Tucson, Arizona, United States of America (USA) (5 Apr 1976).

In Solar energy: fuel and food workshop.

Energy needs in agriculture, and research in this area, especially in the area greenhouses, are mentioned briefly. (MHR)

490 (CONF-760492—, pp 11-14) **Practical application of energy saving ideas.** Gerhart, A.W. (Gerhart and Son Greenhouse, Inc., North Ridgeville, OH). 1976.

From The solar energy fuel and food workshop; Tucson, Arizona, United States of America (USA) (5 Apr 1976).

In Solar energy: fuel and food workshop.

Some of the costs involved in operating a vegetable greenhouse on a commercial scale in the northern hemisphere are presented, with emphasis on energy use today and energy saving techniques now in use. The use of a CO_2 atmosphere and artificial lighting are discussed. The costs per acre of greenhouse for various fuels vs. solar heating are discussed. (MHR)

491 (CONF-760492—, pp 28-40) **Greenhouse solar heating: techniques and economics.** Wiegand, J.B. 1976.

From The solar energy fuel and food workshop; Tucson, Arizona, United States of America (USA) (5 Apr 1976).

In Solar energy: fuel and food workshop.

The rising cost and decreasing availability of fuels used in greenhouse space heating led to an evaluation of the techniques which have proved usable for collecting solar energy and distributing the stored heat to greenhouse structures. The modes of operation and performance testing done at Solar Gardens, Longmont, Colorado, are evaluated. Alternate schemes and configurations of solar heating in greenhouse structures are discussed, and a cashflow analysis for a trial project is exhibited. Products useful in greenhouse solar heating, including controls available now, and collector and heat storage systems available soon, are discussed briefly. Practical considerations in adapting existing greenhouse structures to solar heat are discussed.

492 (CONF-760492—, pp 51-60) **Performance of non-integral solar collector greenhouses.** McCormick, P.O. (Lockheed—Huntsville Research and Engineering Center, AL). 1976.

From The solar energy fuel and food workshop; Tucson, Arizona, United States of America (USA) (5 Apr 1976).

In Solar energy: fuel and food workshop.

A test was conducted of a solar heating system for a greenhouse, making use of solar collectors separate from the greenhouse. The test has been continuous since October 14, 1975, using conventional electric heating for backup. To date, the solar heating system has provided 75 percent of the heat required by the greenhouse. The results of the test are being compared with the predicted performance with good correlation. The economics of solar heating of a greenhouse is discussed.

493 (CONF-760492—, pp 61-73) **Temperature and humidity in a solar heated greenhouse ventilated with deep mine air.** Walker, J.N.; Duncan, G.A.; Buxton, J.W.; Anastasi, D.T. (Univ. of Kentucky, Lexington). 1976.

From The solar energy fuel and food workshop; Tucson, Arizona, United States of America (USA) (5 Apr 1976).

In Solar energy: fuel and food workshop.

The possibility of using air drawn from a mine or deep cavern for greenhouse environmental control is considered. The quality of mine air and temperature and humidity in the greenhouse are discussed. A typical winter record during a four-day cold period, beginning February 15, 1973, and a typical four-day period of relatively, clear warm weather, beginning July 28, 1973, are shown. The physical arrangement for the experimental, mine-air-ventilated greenhouse is sketched. (MHR)

494 (CONF-760492—, pp 74-87) **Growth of selected plants in a mine-air-ventilated greenhouse.** Buxton, J.W.; Walker, J.N.; Anastasi, D.; Collins, L.; Knavel, D. (Univ. of Kentucky, Lexington). 1976.

From The solar energy fuel and food workshop; Tucson, Arizona, United States of America (USA) (5 Apr 1976).

In Solar energy: fuel and food workshop.

A greenhouse was constructed adjacent to an abandoned coal mine shaft and ventilated with mine air. The temperature at night within the greenhouse was generally maintained at 50 to 55°F and 60 to 75°F during the day when solar energy was available. The relative humidity remained at 100 percent day and night during cloudy weather and was reduced to as low as 40 to 50 percent on bright days. The carbon dioxide concentration of the mine air was 600 to 700 ppM. The environment created by the continuous ventilation of the mine air into the greenhouse is potentially excellent for the growth of many greenhouse crops. Lettuce and spray chrysanthemums grown in the greenhouse from October to March were good to excellent in quality. Chrysanthemums were rooted in the environment with 14 days of sticking and were of commercial quality. Other crops, such as cineraria, calceolaria, a pot chrysanthemum and snapdragons, did not grow as well. A bacterial disease on the chrysanthemums was observed, and a physiological condition similar to oedema affected leaves of lettuce.

495 (CONF-760492—, pp 88-109) **Development of a low-cost solar heating system for greenhouses.** Mears, D.R.; Baird, C.D. (Univ. of Florida, Gainesville). 1976.

From The solar energy fuel and food workshop; Tucson, Arizona, United States of America (USA) (5 Apr 1976).

In Solar energy: fuel and food workshop.

A system has been developed and tested for storing large quantities of warm water under a bench in a greenhouse and transferring the stored heat to the greenhouse when needed. The unit can be constructed of low-cost material and, therefore, can have large storage and heat transfer capacity. Relatively low-cost polyethylene film solar water heaters have been built and their performance characteristics determined. These collectors would appear to be more economical to operate than conventional flat-plate collectors at relatively low temperatures.

496 (CONF-760492—, pp 110-128) **Performance of a hydronic solar greenhouse heating system in Florida.** Baird, C.D. (Univ. of Florida, Gainesville); Mears, D.R. 1976.

From The solar energy fuel and food workshop; Tucson, Arizona, United States of America (USA) (5 Apr 1976).

In Solar energy: fuel and food workshop.

A full-scale greenhouse located at Bradenton, Florida, has been equipped with a complete solar heating system. The system incorporates flat-plate solar collectors, an external insulated storage tank, forced convection water-to-air heat exchangers, and automatic controls for both collection and greenhouse heating modes. The system has operated for part of the 1974—75 winter and the entire 1975—76 winter. Performance data on the various components and on the complete system are presented.

497 (CONF-760492—, pp 129-141) **Proposed solar greenhouse design.** Liu, R.C.; Carlson, G.E. (Agricultural Research Service, Beltsville, MD). 1976.

From The solar energy fuel and food workshop; Tucson, Arizona, United States of America (USA) (5 Apr 1976).

In Solar energy: fuel and food workshop.

The proposed design is the result of the first year's support of the program of the Energy Research and Development Administration and the Agricultural Research Service on solar energy utilization for controlling the environment in plant growth facilities. The problem was approached from a total-system standpoint. The concept was developed from extensive study and evaluation of space heating components, prevailing storage systems, current energy conservation practices, and consideration of crop requirements. The main features of the greenhouse are: (1) placement of a solar collector inside the greenhouse to increase efficiency and reduce cost; (2) possible use of a transparent collector as all or part of the greenhouse glazing; (3) a water-rock dual storage system inside the greenhouse; (4) water or air mass transfer, or both, for year-round heating and cooling; (5) a hot water heater for auxiliary heating; and (6) nocturnal evapo-radiative cooling, supplemented by off-peak use of conventional air conditioner. This solar greenhouse module will involve a 480-square foot opaque collector and the possible addition of up to 790 square feet of transparent collector, 2,560 gallons of water, and 63 tons of rock. Energy distribution in the greenhouse will be accomplished by radiation, conduction and natural convection, and forced-air circulation will be through open-core cinderblock air ducts under the two storage units.

498 (CONF-760492—, pp 142-159) **Using solar energy to heat plastic film greenhouses.** Roberts, W.J.; Simpkins, J.C.; Kendall, P. (Rutgers—The State Univ., New Brunswick, NJ). 1976.

From The solar energy fuel and food workshop; Tucson, Arizona, United States of America (USA) (5 Apr 1976).

In Solar energy: fuel and food workshop.

Research on design of low-cost collectors, efficient and functional heat storage, the reduction of heat losses, and the use of new designs for heating double-film greenhouses with low temperature water are discussed. The collector is designed with four layers of 6-mil clear ultraviolet-stabilized plastic and one layer of black arranged to provide structural stability and some insulation. The black layer is sandwiched between two air-inflated sections of clear film. Water flows down between the inner layer of the front inflated section and the black layer, and is collectd in a trough and returned to storage. A porous concrete floor is part of the storage system. Heat loss reduction methods, heat exchanger design, costs, and the combined system are discussed. (MHR)

499 (CONF-760492—, pp 173-190) **Solar heating of greenhouses in the northeast.** Price, D.R.; Wilson, G.E.; Froehlich, D.P.; Crump, R.W. (Cornell Univ., Ithaca, NY). 1976.

From The solar energy fuel and food workshop; Tucson, Arizona, United States of America (USA) (5 Apr 1976).

In Solar energy: fuel and food workshop.

Research in the areas of solar collection, heat storage techniques, mathematical modeling, greenhouse insulating techniques, and investigation of a unique solar heated residence are discussed. To store heat, a system was installed to use the soil block beneath the greenhouse as a heat storage medium. Preliminary analysis with this concept indicates that it may have limited potential in terms of effectiveness as a heat storage unit. A technique to use segregated rock storage beds for storing excess solar energy is under study. An analysis of using only the greenhouse as a collector versus using a combination of the greenhouse and external collectors is presented. A model has been written to predict the steady-periodic thermal behavior of a greenhouse. Test data from existing greenhouses indicate that the model accurately predicts the thermal behavior. The model was used to simulate different coverings and insulation of the greenhouse and results are given. An orthorhombic shaped solar heated house is described and an analysis of its efficiency is discussed. A computer simulation program was used to evaluate the design and thermal behavior of the structure.

500 (CONF-760492—, pp 191-212) **Energy conservation systems for greenhouses.** White, J.W.; Aldrich, R.A.; Vedam, K.; Duda, J.L.; Rebuck, S.M.; Mariner, G.R.; Smith, J.R. (Pennsylvania State Univ., University Park). 1976.

From The solar energy fuel and food workshop; Tucson, Arizona, United States of America (USA) (5 Apr 1976).

In Solar energy: fuel and food workshop.

Twenty different materials were tested for their potential as heat loss barriers during dark periods. The use of these internal curtains, the problems involved, and the energy saving are discussed. The greenhouse as solar collector and possible energy storage media are presented. The possibility of a self-fogging roof is discussed and various materials are mentioned. (MHR)

501 (CONF-760492—, pp 213-222) **Liquid foam insulation systems for greenhouses.** Groh, J.E. (Univ. of Arizona, Tucson). 1976.

From The solar energy fuel and food workshop; Tucson, Arizona, United States of America (USA) (5 Apr 1976).

In Solar energy: fuel and food workshop.

Liquid foam insulation is a method of reducing nighttime energy losses from roofs of greenhouses. This system utilizes a liquid-based foam insulation material placed at night between two layers of polyethylene in the roof of a greenhouse and has the calculated potential of reducing the night heat losses from greenhouse roofs by 85 percent. Actual measurements on a test greenhouse have produced overall savings of 47 percent when compared to an unfoamed two-layered polyethylene greenhouse. The test unit has permanently insulated walls in order to isolate the roof heat loss studies.

502 (CONF-760492—, pp 223-242) **Design criteria for greenhouse-residences.** Zornig, H.F.; Davis, M.; Bond, T.E. (ARS-USDA, Clemson, SC). 1976.

From The solar energy fuel and food workshop; Tucson, Arizona, United States of America (USA) (5 Apr 1976).

In Solar energy: fuel and food workshop.

The design concepts and criteria and one prototype design that was developed are described. The heating and cooling loads are analyzed. Several types of greenhouse-residence models are sketched. (MHR)

503 (CONF-760492—, pp 243-253) **Residential environmental control utilizing a combined solar collector-greenhouse.** Jensen, M.H.; Hodges, C.N. (Univ. of Arizona, Tucson). 1976.

From The solar energy fuel and food workshop; Tucson, Arizona, United States of America (USA) (5 Apr 1976).

In Solar energy: fuel and food workshop.

A demonstration in the heating of a residential unit through the use of a combined solar collector-greenhouse is presently in operation at the Environmental Research Laboratory (ERL) of the University of Arizona. The model is a research and development tool to evaluate the economic and environmental desirability of developing such units as part of rural residential buildings to reduce the requirements for fossil fuels and, at the same time, enhance the home environment and add an increment of food production potential. The integration and performance of four concepts in environmental control are being evaluated: a venetian blind solar collector, rock storage for heated or cooled air, advanced methods of evaporative cooling, and liquid foaming of a greenhouse ceiling for nighttime insulation. Measurements are being made on the quantity of heat energy collected and its operational efficiency within the residential unit, plus the amount of heat that can be retained at night in the test unit by foam insulating the greenhouse roof. Horticultural productivity tests are being conducted within the unit to evaluate the food production potential.

504 (COO/2705—1) **Solar heating and cooling of mobile homes, Phase II. Final report.** Jacobsen, A.A. Dec 1976. Contract EY-76-C-02-2705. 134p. Dep. NTIS, PC A07/MF A01.

The specific objectives of the Phase II program were: (1) through system testing, confirm the feasibility of a solar heated and cooled mobile home; (2) update system performance analysis and provide solar heating and cooling computer model verification; (3) evaluate the performance of both an absorption and a Rankine air conditioning system; (4) perform a consumer demand analysis through field survey to ascertain the acceptance of solar energy into the mobile home market; and (5) while at field locations to conduct

the consumer demand analysis, gather test data from various U.S. climatic zones. Results are presented and discussed. (WHK)

505 (EPA—600/2-76-212, pp 323-332) **Potential role of solar energy in conservation for building, heating, and cooling.** Biancardi, F.R.; Meader, M.D. (United Technologies Research Center, East Hartford, CT). Aug 1976.

From Symposium on environment and energy conservation; Denver, Colorado, USA (3 Nov 1975).

In Symposium on environment and energy conservation.

A number of solar collector configurations and air conditioning subsystems are being investigated for use in solar-powered building, heating, and cooling applications. The pertinent characteristics and operating features of representative flat-plate and focusing-type collectors as well as typical Rankine-cycle, absorption, and dessicant air conditioning systems are briefly described. Estimates of the energy savings possible for the remainder of this century, with widespread utilization of solar-powered systems, are also presented. A Rankine-cycle turbocompressor air conditioning and heating system has been designed, fabricated, and tested. The design features of the system are described and results obtained during the performance testing of the system are presented. The test results provide a convincing demonstration of the feasibility of operating a Rankine cycle-turbocompressor air conditioning and heating system at system temperature levels consistent with present-day, flat-plate solar collectors. During the testing of the demonstration system, more than 4 tons of cooling and in excess of 60 hours of safe, reliable operation were obtained. Most significant was the operation of the system over a range of turbine inlet temperatures from approximately 165°F to more than 215°F, during which the system performance goals were met or exceeded.

506 (LA-UR—77-1517) **Energy conservation by adaptive control for a solar heated building.** Farris, D.R.; Melsa, J.L.; Murray, H.S.; McDonald, T.E.; Springer, T.E. 1977. Contract W-7405-ENG-36. 8p. (CONF-770915—1). Dep. NTIS, PC A02/MF A01.

From International conference on cybernetics; Washington, District of Columbia, USA (19 Sep 1977).

Identification and optimal control techniques are combined to form an adaptive optimal control strategy which is used to minimize the auxiliary energy consumption for a solar heated building. The adaptive optimal control strategy is described and application of the adaptive optimal controller to the heating, ventilating, and air conditioning (HVAC) system in an appropriate building is modeled. The building used is the newly completed National Security and Resources Study Center (NSRSC) at the Los Alamos Scientific Laboratory (LASL). The NSRSC uses an 8000 sq. ft. solar collector to provide energy for heating and cooling the building. A cost functional to define optimal performance of the HVAC system and an identification process to produce a linearized building model are combined to yield an adaptive linear regulator solution. Although solar energy is used for both heating and cooling the NSRSC, only the results from the heating simulation are available for presentation here. Energy savings predicted by the model when compared to a conventional control system are described and an alternate system configuration is briefly discussed. Plans for actual implementation of the adaptive optimal controller are discussed.

507 (TID—27681) **Parameter grouping and regionalizing to simplify solar life cycle cost models for application to solar heating and cooling of buildings. Final report.** Halldane, J.F.; Meckler, G.; Degelman, L.O. Dec 1976. Contract EX-76-C-01-2410. 101p. Dep. NTIS, PC A06/MF A01.

A generalized life cycle energy and costing assessment process has been developed. The procedure involves a generation of problem scenarios, system alternatives, energy flow, cost items, and cash flows. These culminate in comparative parameters for an assessment which is relevant to the interested parties. Procedures for grouping and regionalizing are developed from a theoretical base. Groups can be excluded for irrelevancy, or combined both from a consistency in parameter variation or for a comparable uncertainty. Uncertainty is a play between the minimum-mode-maximum of parameter ranges and the confidence in their estimation. A solar home water heater case is used to illustrate a life cycle cost matrix. An analysis of variation demonstrates a sensitivity to the natural variation in demand and insolation data which often exceeds those of the system parameters. An extensive appendix expands the analytical models in a consistent manner. A generalized energy flow model is introduced which traces the power, energy and annual energy through the systems. Various factors are proposed as meaningful comparative measures.

508 **Solar energy and heat-pumps in northern climate.** Healey, J.J.; Stewart, R. (Univ. of Albany). pp 13.6-13.10 of In Proceedings of the 1977 annual meeting of the American Section of the International Solar Energy Society. Volume 1, Sections 1—13. Beach, C.; Fordyce, E. (eds.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1977).

From Solar world meeting; Orlando, Florida, USA (6 Jun 1977).

See CONF-770603—P1.

The operating and performance characteristics of the heating systems in the State University of New York at Albany Alumni House-Conference Center are discussed. This 8,000 sq. ft. building incorporates two viable, energy conservative, candidate heating systems. A solar assisted heat-pump system consisting of 2,300 sq. ft. of flat plate collectors, a twenty (20) ton water-to-water heat pump, 8,000 gal. (water) heat storage, and electric auxiliary is investigated, as is an air source heat pump system consisting of two 12-ton air-to-water heat pumps with electric auxiliary. A sixty (60) point data monitoring system is utilized in conjunction with the SUNYA computer to generate performance data on the HVAC systems. Predictions from computer simulations of these systems are compared with the real performance derived from data collected on site. Verified computer models are subsequently used to predict "design year" performance of the systems. Energy and economic considerations of the two alternative heating systems are analyzed based on climatic and economic data for Albany, N.Y.

509 **Solar heating and cooling of mobile homes test results.** Jacobsen, A.S. (General Electric Co., Valley Forge, PA). pp 13.11-13.15 of In Proceedings of the 1977 annual meeting of the American Section of the International Solar Energy Society. Volume 1, Sections 1—13. Beach, C.; Fordyce, E. (eds.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1977).

From Solar world meeting; Orlando, Florida, USA (6 Jun 1977).

See CONF-770603—P1.

In 1974, a government grant was awarded to General Electric to develop an integrated solar heated and cooled mobile home. A first generation solar mobile home was designed and built using a standard mobile home and state-of-the-art solar heating and cooling equipment. Integrated completely into the mobile home is the solar system with the entire package designed to be factory-assembled and road transported in a conventional manner. In fact, during the last year, the mobile home traveled approximately 8,000 miles. System testing started in June 1975, and since that date the solar mobile home has been in continuous operation, with the exception of times when the unit was being displayed at shows in Chicago, Los Angeles and Louisville. The primary objectives of the solar mobile home test program were to show through system testing the feasibility of a solar heated and cooled mobile home, and to provide verification of the solar heating and cooling computer model. Also performed was an evaluation of both a solar driven absorption and a Rankine air conditioning system under steady state and transient conditions. Results are presented and discussed.

510 **Evaluation of a residential solar heating and cooling system with high performance evacuated tubular collectors.** Duff, W.S.; Lof, G.O.G.; Winn, C.B.; Leflar, J.; Meredith, D. (Colorado State Univ., Ft. Collins). pp 13.16-13.20 of In Proceedings of the 1977 annual meeting of the American Section of the International Solar Energy Society. Volume 1, Sections 1—13. Beach, C.; Fordyce, E. (eds.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1977).

From Solar world meeting; Orlando, Florida, USA (6 Jun 1977).

See CONF-770603—P1.

The Solar Energy Applications Laboratory of Colorado State University has completed the design, construction, and installation of a complete set of evacuated tubular collectors on a test bed behind Solar House I. The Corning evacuated tube collector (December 16, 1976 to December 31, 1977) and the Philips evacuated tube collector (January 16, 1978 to January 31, 1979) are being used sequentially to operate the heating and cooling system of Solar House I. Data have been collected from December 16, 1976 and analyses are being performed on these data to provide an evaluation of the two new collectors and comparison with the present conventional collector as part of a residential heating and cooling system that is otherwise identical in every way. While the Solar House I heating and cooling load requirement is being supplied from the evacuated tube collector thermal storage tank, the flat plate collector operates in conjunction with a separate heat storage tank. The flat plate collector storage tank functions as though this system were supplying the Solar House I load requirement by using the actual load data and two tank temperatures to control tank heat rejection. Thus a comparison between the flat-plate and evacuated tube systems under identical load and environmental conditions can be made. Performance comparisons are also being made with a flat-plate air system, Solar House II, and an Owens Illinois evacuated tube liquid system, Solar House III, located adjacent to Solar House I. These buildings have load characteristics that are nearly identical to Solar House I. The details of the design and installation of the systems and the instrumentation and data collection approach are described. Initial comparative performance results are presented.

511 Shenandoah solar recreational center: an overview. Williams, J.R. (Georgia Inst. of Tech., Atlanta). pp 13.23-13.27 of In Proceedings of the 1977 annual meeting of the American Section of the International Solar Energy Society. Volume 1, Sections 1—13. Beach, C.; Fordyce, E. (eds.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1977).

From Solar world meeting; Orlando, Florida, USA (6 Jun 1977).

See CONF-770603—P1.

The recently completed Shenandoah Solar Community Center is at present the world's largest building to have most of its heating, air conditioning, and domestic hot water needs met by solar energy. The Shenandoah Solar Community Center incorporates 1,042 sq. meters (11,213 sq. ft.) of double glazed black chrome selectively coated copper flat plate solar collectors oriented at an angle of 45° to the south with 2,415 sq. meters (26,000 sq. ft.) of highly polished aluminum (Alcoa Coilzak) reflectors to provide energy for heating and air conditioning the 5,481 sq. meter (59,000 sq. ft.) community center. Each of 63 solar collectors are 2.63 meters (8.61 ft.) high and 6.3 meters (20.7 ft.) wide with copper internal-tube absorber plates insulated on the back to a K value of 0.28 watts/ft²/°C (0.05 BTU/ft²/°F/hr). Thermal storage is provided by one 56.8 cubic meter (15,000 gallon) hot water storage tank and two 113.6 cubic meter (30,000 gallon) chilled water storage tanks. These tanks are buried beneath the earth berm surrounding the sides of the building. The building has been operating in solar heating and cooling modes since early April, 1977. In addition to utiiizing solar energy, this building incorporates a number of unique energy conserving features. The earth bermed around the side of the building creates, in effect, an underground building with minimal heating requirements. The trusses that support the roof form a sawtooth with optimum angles for positioning the collectors and reflectors. The mechanical room is contained in the center of the lobby with all components and pipes color coded and properly labeled so that visitors are able to understand how the system operates. The system is currently operating with both IBM and Georgia Tech collecting data for its performance evaluation. The solar system is expected to provide 95% of the space heating, 64% of the air conditioning, practically all of the domestic hot water, and heat for a nearby swimming pool.

512 Monitoring and evaluation of solar heating in northern New England. Converse, A.O. (Dartmouth College, Hanover, NH). pp 13.28-13.32 of In Proceedings of the 1977 annual meeting of the American Section of the International Solar Energy Society. Volume 1, Sections 1—13. Beach, C.; Fordyce, E. (eds.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1977).

From Solar world meeting; Orlando, Florida, USA (6 Jun 1977).

See CONF-770603—P1.

Five buildings of different designs have been characterized by field monitoring. These data were then used in a computer simulation for a standard year to provide the basis for comparison of the different designs. The economic performance is characterized by the rate of return. Two water heating installations were also studied.

513 Impact of domestic solar heating systems utilizing off peak storage on electric utilities. Eltimsahy, A.H.; Molyet, R.G.; Wozniak, E.J. Jr. (Univ. of Toledo). pp 24.6-24.10 of In Proceedings of the 1977 annual meeting of the American Section of the International Solar Energy Society. Volume 1, Sections 14—25. Beach, C.; Fordyce, E. (eds.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1977).

From Solar world meeting; Orlando, Florida, USA (6 Jun 1977).

See CONF-770603—P2.

The impact of using solar energy for domestic space heating systems that utilize off-peak storage (using electric resistance heating) on the electric power network is discussed. The methodology used is that of digital computer simulation of an existing system on the campus of The University of Toledo (the system uses Libbey-Owens-Ford's flat plate solar collector). The program inputs parameters such as component sizes, initial temperatures, set temperatures, solar insolation for each day the simulation is run, the outside air temperature, etc. The effects of these systems on a northwestern Ohio electric utility are evaluated. Plots of the new demand curves and load factors are analyzed. The runs presented are for different values of: number of houses in the area utilizing these systems, heat pump size and off-peak storage period.

514 Regional conditions and the feasibility of using low-temperature solar heaters in the mines of Yakutia. Kim, V.P. (Inst. of Physical and Tech. Problems, Novosibirsk, USSR). No. 1, 70-75(1977). (In Russian).

The urgency of the problem of regulating heating conditions in mines in permafrost regions is discussed. Conditions for using solar technology in Yakutia are examined. Possible systems for storing solar energy in the rocks surrounding mine openings are described. It is shown that solar air heaters are more efficient than pipe heaters for controlling air temperature in mines.

515 Computer model of a solar-assisted heating design approach implemented on a minicomputer installation. D'Ippolito, R.; Krutz, R. (Carnegie-Mellon Univ., Pittsburgh). pp 31-34 of In Modeling and simulation. Volume 7, Part 1. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P1.

Solar energy heating simulation and life-cycle cost estimation programs have traditionally been designed to run on relatively large computer installations with resulting accrual of costs for yearly runs with many iterations. The objective of the work described is to develop techniques to permit accurate simulation and estimation programs to be executed on minicomputer installations available at most facilities. Techniques applied to determination of driving functions and system modeling for a flat-plate collector-based solar heating system are described.

516 Solar-heating-system simulation model. Eltimsahy, A.H.; Copass, C.H. (Univ. of Toledo). pp 1092-1097 of In Modeling and simulation. Volume 7, Part 2. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P2.

A simulation model for a solar heating system which is suitable for control and optimization studies is developed. The effect of temperature stratification in the heat storage device model is considered by simulating two storage chambers of variable volume. The gradient search method is applied to study optimal sizing of solar heating components for The University of Toledo solar house.

517 Computer system for a solar heating research station. Copass, C.H. (Univ. of Toledo); Eltimsahy, A.H.; Voith, R.P. pp 1098-1102 of In Modeling and simulation. Volume 7, Part 2. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P2.

The building of a minicomputer system dedicated to the task of solar heating research is described. The computer system which is connected to a heavily instrumented solar heating system is required to perform three major tasks. First, to perform complete on-line real-time data monitoring. Second, to allow for an on-line control with the intention of testing possible optimal and suboptimal controllers. Third, to simulate the operation of a full-scale solar heating system based on the concurrent operation of the smaller real system. The programs developed together with the hardware form a research tool for solar-heating investigations.

518 Experimental solar heating-cooling system model tests of a full-scale building system. Namkoong, D. (Lewis Research Center, Cleveland). pp 1103-1113 of In Modeling and simulation. Volume 7, Part 2. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P2.

An experimental solar heating and cooling system model was built and operated, combining elements that are programmable--heating and/or cooling load of a building, collected solar energy--with experimental equipment. The system model was based on the loads and components used in the Solar Building Test Facility (SBTF) which includes a 1394 square meter solar collector field, at NASA-Langley. Operations covered 5 continuous days under summer conditions. For the system model, up to 55% of the simulated collected solar energy was used for the building load. This amount constituted 35% of the building cooling load. Heat loss was significant. If tank heat loss were eliminated, and therefore more similar to the SBTF, 75% of the collected solar energy would be used. This amount would supply approximately 50% of the building cooling load.

AGRICULTURAL AND INDUSTRIAL PROCESS HEAT

519 (PB—267210) Research on the application of solar energy to the food drying industry. Final report. Lukes, T. 31 Dec 1975. 118p. (NSF/RANN/SE/ERT—7419063/FR/75/4). NTIS PC A06/MF A01.

Several solar collector configurations were investigated as to their suitability for drying food crops. Various fruits and vegetables

were dried using a mixture of solar energy and steam heat or solar energy alone. Cost estimates (based on initial construction material costs only) indicate that when the price of oil delivered to this country reaches $17 per barrel, then solar energy becomes competitive. An earlier report included in this document consists of results on related tasks including: literature review of dehydrated food industry; current and projected energy demands; projected cost studies for dehydrating carrots and prunes in the years 1975, 1985 and 2000; socio-legal implications; and economic and technical feasibility of solar energy to the food drying industry.

520 (UCRL—52254) **Economic methodology for solar-assisted industrial process heat systems: the effect of government incentives.** Dickinson, W.C.; Freeman, H.J. 6 Jun 1977. Contract W-7405-ENG-48. 40p. Dep. NTIS, PC A03/MF A01.

Standard life-cycle costing techniques are used to establish an economic methodology and determine the economic attractiveness of solar thermal systems for industrial process heat and the effect of government-sponsored economic incentives. One particularly attractive incentive is to reward those who save fossil fuel as a result of installing a solar thermal system with an income tax rebate—a "fuel-savings incentive". Another appealing incentive is to provide low-interest, government-backed loans for the construction of these systems. It is concluded that such incentives will be needed to open a mass industrial market for solar thermal systems in the near future.

WATER HEATING

REFER ALSO TO CITATION(S) 511, 1039

OTHER

521 (UCID—17510) **Solar technology applications: a literature review of solar thermal powered irrigation systems.** Newkirk, H.W. 30 Jun 1977. Contract W-7405-ENG-48. 20p. Dep. NTIS, PC A02/MF A01.

The background, operation, and need for solar thermal powered pumps for irrigation is reviewed, and a compilation of 38 literature references with summaries is presented. (WHK)

522 **Nitinol engine development.** Banks, R.; Kopa, R.; Wahlig, M. (Univ. of California, Berkeley). pp 24.25-24.27 of In Proceedings of the 1977 annual meeting of the American Section of the International Solar Energy Society. Volume 1, Sections 14—25. Beach, C.; Fordyce, E. (eds.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1977).

From Solar world meeting; Orlando, Florida, USA (6 Jun 1977).

See CONF-770603—P2.

Nitinol, a nickel-titanium alloy with shape-memory properties, is being used as the working element in the development of engines for the conversion of thermal energy to mechanical work. The operating principles of the Nitinol Cam-Track engine are described.

SOLAR COLLECTORS AND CONCENTRATORS

REFER ALSO TO CITATION(S) 445, 446, 455, 473, 492, 510

523 (CONF-760492—, pp 15-27) **Basic solar collector design and considerations.** Peck, J.F. (Univ. of Arizona, Tempe). 1976.

From The solar energy fuel and food workshop; Tucson, Arizona, United States of America (USA) (5 Apr 1976).

In Solar energy: fuel and food workshop.

A few basic principles of collector design and use are presented, as well as developments in solar energy. A framework with which to organize the various general types of solar collectors is also presented. (MHR)

524 (CONF-760492—, pp 41-50) **Solar pond for heating greenhouses and rural residences: a preliminary report.** Short, T.H.; Roller, W.L.; Badger, P.C. (Ohio Agricultural Research and Development Center, Wooster). 1976.

From The solar energy fuel and food workshop; Tucson, Arizona, United States of America (USA) (5 Apr 1976).

In Solar energy: fuel and food workshop.

A full-scale experimental solar pond was constructed adjacent to a greenhouse, designed to meet all the winter heat requirements of a 186m^2 three bedroom home or 98m^2 greenhouse in Wooster, Ohio. The design and establishment of the solar pond, radiation collection and heat storage, heat removal, and instrumentation are discussed. The salt concentration for 3 periods since construction are shown. The temperature profile on three different dates are shown. The changes in maximum pond temperature are plotted. The soil temperature below the pond was monitored in relation to the bottom pond water temperature and a reference soil temperature in depth to the pond bottom. (MHR)

525 (CONF-760492—, pp 160-172) **Glass solar collectors for greenhouses and integrated geeenhouse—residential systems.** Deminet, C. (Boeing Co., Seattle). 1976.

From The solar energy fuel and food workshop; Tucson, Arizona, United States of America (USA) (5 Apr 1976).

In Solar energy: fuel and food workshop.

An all-glass solar collector is under development which can be produced by an automated glass forming process. The solar energy is absorbed directly in a black working fluid. A modification of this concept, using fluids with specific spectral bandpass characteristics, is being studied. Collectors utilizing transparent collectors of this type can be used for greenhouses. Fluids can be tailored to pass the part of the solar spectrum needed for plant growth and to absorb the undesirable radiation. The surplus solar energy absorbed can then be used to aid in heating, desalinating sea or brackish water, refrigeration or power generation. This development may make greenhouse farming possible in hot arid areas, using sea or brackish water for irrigation, under environmental conditions that were formerly impractical.

526 (COO/2830—1) **Maintenance costs of solar air heating systems. Final report, December 1, 1975—May 31, 1977.** Ward, J.C.; Lof, G.O.G.; Hadley, L.N. Apr 1977. Contract EY-76-S-02-2830. 37p. Dep. NTIS, PC A03/MF A01.

The annual maintenance cost of the overlapped glass plate type of solar air heating system expressed as a percent of the original installed cost appears to be in the vicinity of about 1 percent per year. This figure can be compared with the decline in performance if no maintenance is performed of about 1 percent per year. While these figures are both based on an air-heating solar system, the corresponding costs for a liquid-heating solar system are not expected to be any less. In addition, these figures were obtained from one solar air heating system first put into operation 20 years ago. The transmissivity of the glass covers and the absorptivity of the old and new absorbers were measured. Both the glass covers and the old absorbers had been in continuous use for 20 years. Measurements were made over the spectral range 0.35 to 2.2 μm which includes 99.35 percent of the incident solar spectrum at sea level. The measurements indicate that both the glass covers and the old absorbers have retained a high efficiency over this period. The solar transmittance of the low iron content glass covers with a low reflectivity coating was 95.3 percent per sheet.

527 (COO/2858—4) **Design considerations for residential solar heating and cooling systems utilizing evacuated tube solar collectors.** Ward, D.S.; Ward, J.C. 1977. Contract EY-76-S-02-2858. 19p. Dep. NTIS, PC A02/MF A01.

As solar heating systems become a commercial reality, greater efforts are now being employed to incorporate solar cooling components in order to obtain a complete solar heating and cooling system, and thus take advantage of the cost-effectiveness of year-round use of the solar equipment. The solar heating and cooling system design presented incorporates design considerations which have been obtained from previous experimental efforts utilizing evacuated tube solar collectors. These advanced collectors are capable of significantly higher efficiencies, even at the higher temperatures required for solar cooling operation. Most of the considerations presented are based on the experience gained in the design and performance of the solar heating and cooling systems for CSU Solar Houses I through IV.

528 (MDC-G—6531) **Solar collector field subsystem program. Volumes I and II.** Jan 1977. Contract EY-76-C-04-0789-077671. 184p. Dep. NTIS, PC A09/MF A01.

The objective of the solar collector field subsystem program is the design, development, installation, and operation of distributed solar collectors in the total energy test bed under development at Sandia Laboratories, Albuquerque, NM. This test bed provides a system level operational facility, prior to the large-scale demonstratlens for engineering evaluation and development of individual components of the solar energy system. The preliminary design and component testing of a collector subsystem for this facility, using a fresnel lens for solar concentration, is described. Specifically, a cast acrylic fresnel lens which provides a proven, rugged, durable optical surface capable of providing high solar energy transmission efficiency even after extensive environmental exposure was developed.

529 (NTIS/PS—77/0457) **Solar energy collectors and concentrators. Volume 1. 1964-1975 (citations from the NTIS data base). Report for 1964—1975.** Hundemann, A.S. Jun 1977. 175p. NTIS PC N01/MF N01.

Federally-funded research on solar energy collectors and concentrators for use in solar heating and cooling of buildings and solar thermal electric power systems is discussed. Topic areas cover flat plate collectors, heliostats, shallow ponds, linear focused collectors, solar reflectors, and solar energy absorbers. Emphasis of the bibliography is on basic research rather than applications studies. Concentration of solar energy for spacecraft application is excluded, except in those cases in which the technology may have terrestrial

application. (This updated bibliography contains 170 abstracts, none of which are new entries to the previous edition.)

530 (NTIS/PS—77/0458) **Solar energy collectors and concentrators. Volume 2. 1976—May 1977 (citations from the NTIS data base). Report for 1976—May 1977.** Hundemann, A.S. Jun 1977. 227p. NTIS PC N01/MF N01.

Federally-funded research on solar energy collectors and concentrators for use in solar heating and cooling of buildings and solar thermal electric power systems is discussed. Topic areas cover flat plate collectors, heliostats, shallow ponds, linear focused collectors, solar reflectors, and solar energy absorbers. Emphasis of the bibliography is on basic research rather than applications studies. Concentration of solar energy for spacecraft application is excluded, except in those cases in which the technology may have terrestrial application. (This updated bibliography contains 222 abstracts, all of which are new entries to the previous edition.) See also NTIS/PS-77/0457, Solar Energy Collectors and Concentrators. Vol. 1. 1964-1975.

531 (NTIS/PS—77/0459) **Solar energy collectors and concentrators (citations from the Engineering Index data base). Report for 1970—May 1977.** Hundemann, A.S. Jun 1977. 294p. NTIS PC N01/MF N01.

Design, performance, and optimization studies of solar energy collectors and concentrators are covered. Abstracts of worldwide research discuss flat plate collectors, heliostats, shallow ponds, linear focused collectors, solar reflectors, and solar energy absorbers. Emphasis of the bibliography is on basic research rather than applications studies. Concentration of solar energy for spacecraft application is excluded, except in those cases in which the technology may have terrestrial application. (This updated bibliography contains 287 abstracts, 172 of which are new entries to the previous edition.)

532 (SAND—77-1035) **Energy loss by thermal conduction and natural convection in annular solar receivers.** Ratzel, A.C.; Hickox, C.E.; Gartling, D.K. 1977. Contract EY-76-C-04-0789. 49p. (CONF-770847—1). Dep. NTIS, PC A03/MF A01.

From 15. international thermal conductivity conference; Ottawa, Ontario, Canada (24 Aug 1977).

An effective device for the collection of solar energy is the so called parabolic-cylindrical solar collector. In this device, a circular receiver tube, with a suitable selective coating, is enclosed by a concentric glass envelope and situated along the focal line of a parabolic trough reflector. The heat transfer processes which occur in the annular space between the receiver tube and the glass envelope are important in determining the overall heat loss from the receiver tube. In typical high temperature receiver tube designs the rate of energy loss by combined thermal conduction and natural convection is of the same order of magnitude as that due to thermal radiation, and can amount to approximately 6% of the total rate at which energy is absorbed by the solar collector. The elimination of conduction and natural convection losses can significantly improve the performance of a large collector field. Several techniques useful for the reduction of energy loss by thermal conduction and natural convection are considered. The receiver configuration chosen for study is typical of those used in the Solar Total Energy System at Sandia Laboratories. The receiver tube has a "black chrome" selective coating and is 2.54 cm in outside diameter. The inside diameter of the glass envelope is approximately 4.4 cm. Typical operating temperatures of the receiver tube and glass envelope are approximately 573 K and 373 K, respectively.

533 **Concave, mirrored solar collector.** Bezborodko, J.A.I.B. US Patent 4,038,971. 2 Aug 1977. Filed date 22 Oct 1975. 10p.

A concave, mirrored solar collector includes a concave shell, a series of mirrored strips disposed in the shell and acting as the reflecting surface, a support for the shell, and a cover. The reflecting surface serves to focus sunlight on a water-carrying pipe located along a longitudinal axis of the collector. A drive is provided for rotating the collector to "track" the sun. 14 claims, 7 figures.

534 **Finned tube solar energy absorber.** Bauer, C.F. (to UOP Inc.). US Patent 4,036,208. 19 Jul 1977. Filed date 29 Dec 1975. 4p.

An energy absorber for a solar collector assembly comprises an array of closely spaced, parallel tube portions having very high fins which present a large area of exposure to the source of radiation. The finned portions of the absorber are positioned between layers of thin, transparent plastic sheeting. The plastic sheeting contacts most of the circumference of the fins and defines generally closed cell portions between the side walls of adjacent fins which are evacuated so as to minimize convection type heat losses. 5 claims, 3 figures.

535 **Device for receiving or emitting radiation energy.** Laing, N. US Patent 4,015,583. 5 Apr 1977. Priority date 23 Jun 1972, Austria. 4p.

An energy transmission device is described through which energy may pass where the device has an optically active layer for absorbing or reflecting solar energy overlaid by a plurality of parallel extending U-shaped channels where the width of the channels is less than the height to prevent convection currents over the layer. 4 claims, 5 figures.

536 **New concrete solar collector.** Olive, G. **8E**: No. 5, 3-14(10 Jan 1977). (In French with English abstract).

A flat concrete solar collector was developed. The steady-state behavior of this kind of collector was investigated at the draft stage. Conclusions are drawn as to the energy production efficiency values from the field experimental research carried out. 4 refs.

537 **Conceptual design of a parabolic-dish solar collector using simulation techniques.** Gupta, B.P.; Buchholz, R.L. (Honeywell Inc., Minneapolis). pp 646-650 of In Modeling and simulation. Volume 7, Part 1. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P1.

The development of solar concentrators in recent years has produced a wide variety of collectors for the utilization of solar energy. The simulation techniques used to predict the optical and thermal performance of a paraboloid of revolution type solar collector are presented. Conceptual design of a dish concentrator with a fixed receiver size is obtained by parametrically examining the significant variables.

HEAT STORAGE

REFER ALSO TO CITATION(S) 468

538 (AD-A—039702) **Photon energy storage in organic materials: the case of linked anthracenes. Technical report No. 6, 1 Nov 1975—31 Dec 1976.** Jones, G. II; Bergmark, W.R.; Reinhardt, T.E. 15 Mar 1977. Contract N00014-76-C-0442. 30p. NTIS PC A03/MF A01.

Criteria for the photochemical storage of solar energy as latent heat are outlined. Energy-storing valence isomerizations which may be driven by irradiation and which may be reversed by heating with or without a catalyst are described. Data for photoisomerization which utilize 300-500 nm radiation with storage capacities of 50-250 cal/g and with storage efficiencies of 5-10% are summarized. New data concerning linked anthracenes which photoisomerize with phi = 0.2-0.4 are provided. A photocalorimeter for the measurement of storage enthalpies is described. New systems for the practical conversion of solar energy are suggested.

GEOTHERMAL ENERGY

REFER ALSO TO CITATION(S) 953

RESOURCE STATUS AND ASSESSMENT

USA

539 (EPA—600/2-76-212, pp 217-229) **Geothermal energy development.** Kruger, P. (Stanford Univ., CA). Aug 1976.

From Symposium on environment and energy conservation; Denver, Colorado, USA (3 Nov 1975).

In Symposium on environment and energy conservation.

Forecasts and national goals for development of U. S. geothermal resources are given for the year 1985 and the equivalent potential in number of 1000 MWe power plants and in oil consumption in millions of barrels per day. Problem areas in the development of the geothermal energy cycle are listed. A summary of the resource base by resource type is given. Geothermal exploration methods, utilization of geothermal energy, types of geothermal power plants, and environmental impacts of geothermal power production are summarized. The institutional aspects and the national geothermal program are discussed. (MHR)

GEOLOGY, HYDROLOGY, AND GEOTHERMAL SYSTEMS

540 **Yellowstone hot spot: Contemporary tectonics and crustal properties from earthquake and aeromagnetic data.** Smith, R.B.; Shuey, R.T.; Pelton, J.R.; Bailey, J.P. (Department of Geology and Geophysics, University of Utah, Salt Lake City, Utah 84112). **82**: No. 26, 3665-3666(10 Sep 1977).

A compilation of aeromagnetic and new earthquake data is used to characterize the current tectonic activity and crustal properties of the Yellowstone hot spot. Earthquakes located during detailed surveys from 1972 to 1976 occurred west and northeast of the Yellowstone caldera along east-west zones and south of the caldera in north-south zones. The change in trend suggests that Yellowstone is at a vertex of the contemporary tectonic patterns. Seismicity showed variations of maximum focal depths from ~20 km outside the Yellowstone caldera to ~5 km inside the caldera. The frequency of earthquake occurrence was markedly lower within the caldera. Fault plane solutions showed general north-south extension west of the caldera, a suggestion of radial compression near the western caldera rim, and northeast to southeast extension south of the caldera. Spectral analyses of aeromagnetic data indicate the Curie isotherm to be 10 +- 3 km below sea level at the periphery of the caldera. These data support the hypothesis of a magma source within the crust for the Yellowstone hydrothermal activity, but they do not bear on the definition of a deep mantle source for the Yellowstone hot spot.

NON-USA

541 Geothermal alteration of Satsuma Io island. Kinbara, K. (Geol. Survey of Japan, Crustal Geothermics); Shigeno, H.; Okubo, T. No. 272, 9-17(1977). (In Japanese).

Three types of hot spring are found on Satsuma Io island. The springs in and around Io Dake are characterized by strongly acidic waters. Those in the neighborhood of Inamura Dake are weakly acidic and contain iron carbonate. The springs located just outside the caldera wall are neutral and weakly saline. Seawater reacts with the waters of the springs resulting in precipitation of red colored ferric species at Inamura Dake and hydrated aluminosilicates at Io Dake. Surficial geothermal phenomena are restricted to the volcanic areas of Io Dake. The geothermally altered areas observed on Io island originated as a result of both volcanic and hydrothermal activity. In the zone peripheral to the crater fumarole temperatures reach 100°C and temperatures of up to 750°C are found in the crater walls, resulting in an extremely white coloration due to siliceous alteration. In the Busso altered zone the temperatures of the fumaroles reach 100°C and the same type of white siliceous alteration is found.

542 Hydrogeologic studies on the hot springs in Kagoshima city, South Kyushu, Japan. Tsuyuki, T. (Inst. of Earth Sci., Fac. of Sci., Kagoshima Univ., Japan). No. 8, 63-77(1975). (In Japanese).

Hydrogeologic studies on the hot springs in Kagoshima City, Japan, were performed using available geologic information and chemical analyses of water from drilled wells. More than 90 wells have been drilled for thermal water since 1950. They range in depth from 400-800 meters. The basement geology in the area is the Shimanto Formation, composed of sandstone and shale of Cretaceous to Tertiary age. The Shimanto is overlain by the Kekura (Quaternary). An alluvial aquifer carrying fresh water overlies the older rocks. The thermal waters of the area fall into three classifications. A-type is alkaline spring water with a concentration of dissolved solids less than 1 g/kg. It is found in both the Shimanto and Kekura formations. B-type water is saline, ranging from 5/22 g/kg dissolved solids. It is found in the Kekura and Terukuni welded tuff. It is assumed to derive from ancient sea waters held in marine formations. These waters are believed to have migrated to their present locations through gently dipping aquifers. C-type waters are characterized by the presence of chlorides and bicarbonates with dissolved solid concentrations ranging from 1-5 g/kg. It is found in both the Shimanto and Kekura formations over a broad geographic area. The relation between the A and C-types of water is not clear. It is believed that it is partially due to ancient thermal activities and partially as a result of the mixing of A-type and B-type waters during the migration of the older sea water.

543 Heat transfer in hot springs area. Urakami, K. (Fac. of Engg., Hokkaido Univ.). **35**: 15-32(Jun 1976). (In Japanese).

A numerical method was devised for the solution of steady-state heat transfer equations. A simulation of a generalized model of confined aquifer hot springs and a numerical model of the hot water flow system at Tendo hot springs were performed. Results showed that hot water flow directly affects temperature distribution in an aquifer. Total heat energy discharged as hot water from the area increases in proportion to hot water discharge until the discharge reaches a certain limit. Beyond that limit heat energy discharge decreases with increasing water discharge due to cold groundwater mixing. This relation can be used to estimate the maximum discharge from hot springs. The Tendo system was simulated using geologic and hydrologic data. By comparing observed temperature with calculated temperature the quantity of hot water supply was estimated at 800 liters/min.

GEOTHERMAL EXPLORATION AND EXPLORATION TECHNOLOGY

GEOPHYSICAL TECHNIQUES AND SURVEYS

544 (CONF-770836—P2, pp F.2.1-F.2.8) **Definition of fluid-filled fractures in basement rocks.** Albright, J.; Aamodt, L.; Potter, R. (Los Alamos Scientific Lab., NM). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

The Los Alamos Scientific Laboratory Hot Dry Rock Project, has studied the attenuation of acoustic detonator signals traversing pressurized water-filled hydraulic and natural fractures. In contrast to those propagated through unpressurized fractures, signals are attenuated in high-frequency components (1 to 5 kHz) throughout the entire coda, significant scattering is observed, and direct ray paths are changed. The drilling of an exploratory well into the rock volume under investigation confirmed the presence of fractures possessing high fluid conductivity. Confirmation was on the basis of increased flow and temperature anomalies encountered in the exploratory well, and on pressure changes in a nearby pressurized monitoring well.

545 Geophysical surveys of Yellowstone Lake, Wyoming. Otis, R.M.; Smith, R.B.; Wold, R.J. (Department of Geology and Geophysics, University of Utah, Salt Lake City, Utah 84112). **82**: No. 26, 3705-3717(10 Sep 1977).

Reflection, refraction, and paleomagnetic data from Yellowstone Lake, Wyoming, were used to evaluate the Quaternary, tectonic, volcanic, and glacial history of this high mountain lake. Reflection data revealed a paleobasin beneath the main body of the lake containing up to 190 m of lake sediments deposited on intrusive or volcanic bedrock. Prominent reflectors are interpreted to correspond to glaciated layers, erosional surfaces developed during periods of desiccation, and sediments deposited during Recent lake impoundment by rhyolite flows. Volcanic units that outcrop at the south end of the lake are correlated with reflectors that plunge northward beneath the paleobasin, indicating at least 300 m of Recent subsidence of the Yellowstone caldera. Sedimentation rates of 10—13 cm/100 yr were deduced from paleomagnetic logs of shallow cores and suggest a maximum of 200,000 years of deposition within the paleobasin. Refraction data delineated a 1-km-deep, 5.0-km/s layer, interpreted as the top of a shallow crystalline intrusive or volcanic layer possibly associated with the Yellowstone caldera. A rapid decrease in the number of earthquakes occurring 4 km inside the geologically mapped caldera boundary corresponds to a zone of thermal gradients increasing from 200°C/km to 800°C/km and is interpreted to reflect the boundary of a deeper crustal structure, perhaps the edge of a cooling magma body. Contoured water depths obtained from high-resolution 7.5-kHz seismic reflection profiling provide a detailed bathymetric map of Yellowstone Lake.

GEOCHEMICAL TECHNIQUES AND SURVEYS

546 Application of helium investigation to geothermal development, earthquake prediction and resource development. Wakita, H. No. 271, 6-7(Jan 1977). (In Japanese).

It is known that earthquakes are related to the activity of geological features such as faults. Knowing when a fault is becoming active would be a useful tool in earthquake prediction. The measured amount of radioactive gases or gases which are the product of radioactive decay may change according to the activity of geological structures. One of these gases may be helium. The mean concentration of helium in free air is about 5.2 ppm. Helium is produced by alpha-decay of uranium and thorium, with production rates of 12 nanoliters/gram $_{5}U$ /year and 140 nanoliters/gram $_{5}Th$ /year respectively. It is possible for the helium to be trapped in geological structures, resulting in an increase of the free air count in an area where structural failure is occurring. A method was developed in the US to accurately measure helium. A correlation was shown between helium concentration and the water temperature in a geothermal field (Friedman 1975). This could indicate that helium measurements would be a useful tool for both geothermal exploration and earthquake prediction. Large quantities of helium were detected in an earthquake prone area of Matsushiro in Nagano prefecture.

ENVIRONMENTAL ASPECTS AND WASTE DISPOSAL

547 Recent trend of land subsidence in Japan. Yamamoto, S. (Univ. of Tsukuba, Inst. of Earth Sci., Japan). **13**: No. 125, 1-7(1977).

The number of identified areas of subsidence in Japan has reached 40 and is still increasing. In most of the better known

subsidence areas artesian pressures have recovered and the rates have decreased. In some cases rebound has led to problems, particularly in construction of buildings. A rebound of 30 mm from 1974 to 1975 (Kawasaki) was mistakenly interpreted as an earthquake precursor. Newly identified subsidence areas are primarily the result of agricultural irrigation pumpage and gas production. Subsidence resulting from development of geothermal fields has not yet been identified. Recovery of aquifers has mainly resulted from legal restrictions on groundwater withdrawal. Calculation and prediction of subsidence by means of a mathematical model using the relation of compaction to withdrawal was attempted. The results were severely affected by inaccurate available withdrawal data and difficulty in obtaining representative piezometric pressures from deep wells in multi-layered aquifers.

GEOTHERMAL POWER PLANTS

POWER PLANT SYSTEMS AND COMPONENTS

548 Trend of electric facilities in recent geothermal power generation plant. Kubo, H.; Hirosaki, Y.; Morisaki, H.; Sato, K. **51**: No. 2, 117-122(1977). (In Japanese).

A double flash system developed by Mitsubishi Heavy Industries is described and compared to single flash systems. Also described is a portable geothermal power generator which serves as an excellent source of power for the drilling of geothermal wells. This device serves as test unit for the evaluation of the corrosiveness of gases and is most helpful in developing the final design specifications for large scale generating equipment. When air cooled turbines are used in geothermal systems special precautions are necessary to prevent corrosion. These include the sealing of all equipment; adoption of brushless, self exciting generators; coating of all connectors, bolts and terminals; use of epoxy coil insulation; use of stainless steel for all pipes and flanges; and a multiplicity of undercoatings and paint applications. For the remote control of geothermal power plants it is desirable to have an automatic safety shut-down system. If the turbines are hydrogen cooled an automatic hydrogen purging system should be included in the design. Results of corrosion tests performed on various materials at the Otake geothermal field are included.

GEOTHERMAL ENGINEERING

DRILLING TECHNOLOGY AND WELL HARDWARE

549 Composition and method for drilling formations containing geothermal fluid. Fischer, P.W.; Jones, J.C.; Pyle, D.E.; Pye, S. (to Union Oil Company of California). US Patent 4,013,568. 22 Mar 1977. Filed date 11 Dec 1975. 10p.

A fluid composition and method for use in drilling a well into a subterranean formation containing a geothermal fluid at a temperature of about 350°F or above are described. The drilling fluid is made up of a mixture of water or brine, a gas, a corrosion and erosion inhibitor, a lignite to control fluid loss, a salt of a high molecular weight acrylic acid polymer to improve the wall-building and cuttings-carrying properties and, optionally, a foaming agent. (JGB)

GEOTHERMAL DATA AND THEORY

PROPERTIES OF MINERALS AND ROCKS

550 Alteration minerals in Kamoh-cho, Kagoshima prefecture. Tomita, K. (Inst. of Earth Sci., Fac. of Sci., Kagoshima Univ.); Ita, H. No. 8, 1-13(1975). (In Japanese).

Four types of andesites are found in the Akanita area of Kamoh-Cho. They are hydrothermally altered and can be divided into three distinct zones by characteristic mineral associations. Zone I is composed primarily of alunite and contains kaolinite, sericite, chlorite and pyrite. Zone II has a mixed-layer mineral of mica and montmorillonite and contains mordenite, epidote and pyrite. Zone III is abundant in montmorillonite and contains mordenite, alpha-cristobalite, quartz and plagioclase. A mixed-layer mineral of mica/montmorillonite has 27.6 angstroms of (001) reflection and was probably formed by degradation of sericite.

ROCK-WATER-GAS INTERACTIONS

551 Results of investigating water vapor condensation under conditions of the Kura-Araksinskii depression. Alimov, A.K. No. 10, 103-113(Oct 1976). (In Russian).

A presentation is made of the results of investigating the condensation of water vapor and the factors controlling condensation: lithology, temperature, relative humidity and vapor pressure of atmospheric and soil air. The amounts of water condensation in soil and ground water at different depths are compared with the amounts of atmospheric precipitation. On going from heavy soils to light soils the condensation increases by a factor of 1.5 to 2.5. Maximum amounts of condensation are observed in the upper zone of the least water capacity. Drying out of the surface soil layer creates favorable conditions for the entrance of water vapor. Condensation at the ground water level decreases with increasing water mineralization and depth. With increasing depth of water level the percent condensation from atmospheric precipitation also decreases. With increasing water mineralization the percent condensation from atmospheric precipitation increases. It is pointed out that moisture condensation plays a significant role in the water balance of the Kura-Araksinskii depression. (SJR)

TIDAL POWER

WAVE ENERGY CONVERTERS

552 Ocean tide and wave energy converter. Conn, J.L.; Spector, G. US Patent 4,034,231. 5 Jul 1977. Filed date 28 Apr 1975. 4p.

A machine is described for harnessing the motion of ocean waves in order to convert the motion energy into useful electrical power; the machine consisting of a large V-shaped frame, submerged near a beach, having its apex pointed away from the beach, and the frame supporting a series of water turbines connected to an electric generator so that incoming waves toward a beach move along the outer side of the frame while turning the turbine rotors, and outgoing waves moving along the inner side of the frame so to likewise influence turning the turbine rotors.

WIND ENERGY

AVAILABILITY (CLIMATOLOGY)

553 (SAN/1075—2) United States wind speed and wind power duration tables, by months (cumulative distributions). Scientific report No. 1. Coty, U.A.; Court, A.; Reed, J.W. Oct 1975. Contract EY-76-C-03-1075. 532p. Dep. NTIS, PC A23/MF A01.

Cumulative distributions of wind speed (meters per second), adjusted to a standard height of 10 meters (33 feet) above ground at 478 places in the United States, for each month and season, and for the year as a whole, are presented. In addition, cumulative distributions of wind power (watts per square meter), by seasons and for the year, at heights of 10, 50, and 100 meters above ground are given.

554 (UCRL—79896) Numerical and measurement methods of wind energy assessment. Hardy, D.M. Aug 1977. Contract W-7405-ENG-48. 29p. (CONF-770921—2). Dep. NTIS, PC A03/MF A01.

From 3. biennial wind energy conversion systems conference; Washington, District of Columbia, USA (19 Sep 1977).

Information on wind energy assessment is presented concerning site selection methodology, principal components analysis, numerical windfield modeling, and field data collection, data is presented for the San Francisco Bay Area and the island of Oahu, Hawaii.

ECONOMICS

555 Economic competitiveness of windmills. Lapin, E.E. (Aerospace Corp., Los Angeles). **16**: No. 4, 213-220(1977).

The conditions under which windmills become competitive with the generation of electric power from fossil fuels are examined. The influence of cost of construction, financing arrangements, and the future cost of fuels is shown. Energy storage and network arrangements for mills are considered briefly, as are alternate uses for mills, e.g., the utilization of mill output directly for heating or for the production of a fuel.

WIND ENERGY ENGINEERING

APPLICATIONS

556 Analytical performance and economic evaluation of residential wind or wind and solar heating systems. Darkazalli, G. (Univ. of Texas, Arlington); McGowan, J.G. pp 24.20-24.24 of In Proceedings of the 1977 annual meeting of the American Section of the International Solar Energy Society. Volume 1, Sections 14—25.

Beach, C.; Fordyce, E. (eds.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1977).

From Solar world meeting; Orlando, Florida, USA (6 Jun 1977).

See CONF-770603—P2.

A performance and cost model for a variety of wind space and water heating systems for single family residences is presented. In addition to wind powered systems, combined wind and solar systems are modeled and compared to conventional and solar only heating systems. Analytical results are presented for a site in Amherst, Massachusetts. System capital economic details include an itemized cost breakdown of the wind heating system components. The results demonstrate that wind powered systems are presently competitive with electric based heating systems and will be competitive with oil or gas systems in the future.

TURBINE DESIGN AND OPERATION

557 (COO/4130—77/1) **Electrofluid dynamic (EFD) wind driven generator. Final report, September 1, 1975—September 15, 1976.** Minardi, J.E.; Lawson, M.O.; Williams, G. Oct 1976. Contract EY-76-S-02-4130. 90p. (ERDA/NSF/00931—76/T1; UDRI-TR—76-67). Dep. NTIS, PC A05/MF A01.

The study and testing of an electrofluid dynamic (EFD) wind driven generator are reviewed. The EFD wind driven generator directly converts wind energy to electrical energy without moving parts except, possibly, for directing it into the wind. A theoretical analysis is presented of the EFD wind driven generator,including a computer study of electric field geometry and an analysis of charged colloid production requirements. Experimental data obtained with the EFD test rig and a small wind tunnel designed and built for this program are described. Future plans are also detailed.

558 (ERDA/NASA/1004—77/2) **Dynamic blade loading in the ERDA—NASA 100 kW and 200 kW wind turbines.** Spera, D.A.; Janetzke, D.C.; Richards, T.R. 1977. Contract EX-76-A-29-1004. 14p. (NASA-TM—73711; CONF-770539—3). Dep. NTIS, PC A02/MF A01.

From American Wind Energy Association meeting; Boulder, Colorado, United States of America (USA) (13 May 1977).

Dynamic blade loads, including aerodynamic, gravitational, and inertial effects, are presented for two large horizontal-axis wind turbines: the ERDA-NASA 100 kW Mod-0 and 200 kW Mod-0A wind power systems. Calculated and measured loads are compared for the experimental Mod-0 machine in operation at NASA's Plum Brook Station near Sandusky, Ohio. Predicted blade loads are also given for the higher power Mod-0A wind turbine now being assembled for operation as part of the municipal power plant of Clayton, New Mexico. Two major structural modifications have been made to the Mod-0 wind turbine for the purpose of reducing blade loads. A stairway within the truss tower was removed to reduce the impulsive aerodynamic loading caused by the tower wake on the downwind rotor blades. Also, the torsional stiffness of the yaw drive mechanism connecting the turbine nacelle to the tower was doubled to reduce rotor-tower interaction loads. Measured reductions in load obtained by means of these two modifications equaled or exceeded predictions.

559 (ERDA/NASA/1028—77/1) **Drive train normal modes analysis for the ERDA/NASA 100-kilowatt wind turbine generator.** Sullivan, T.L.; Miller, D.R.; Spera, D.A. Jul 1977. Contract EX-76-A-29-1028. 32p. (NASA-TM—73718). Dep. NTIS, PC A03/MF A01.

Natural frequencies as a function of power were determined using a finite element model. Two operating conditions were investigated: operation with a resistive electrical load and operation synchronized to an electrical utility grid. The influence of certain drive train components on frequencies and mode shapes is shown. An approximate method for obtaining drive train natural frequencies is presented.

560 (ERDA/NASA/1028—77/3) **Investigation of excitation control for wind-turbine generator stability.** Gebben, V.D. Aug 1977. Contract EX-76-A-29-1028. 17p. (NASA-TM—73745). Dep. NTIS, PC A02/MF A01.

High-speed horizontal-axis wind-turbine generators with blades on the downwind side of the support tower require special design considerations to handle disturbances introduced by the flow wake behind the tower. Experiments and analytical analyses were made to determine benefits that might be obtained by using the generator exciter to provide system damping for reducing power fluctuations. Excitation control was not a suitable solution for the NASA-Lewis Mod-0 Wind-Turbine Generator.

561 **Compact shrouds for wind turbines.** Igra, O. (Ben-Gurion Univ., Beersheba, Israel). **16**: No. 4, 149-157(1977).

As part of a large project aimed at finding the optimal configuration for an aerogenerator to exploit wind power, an investigation was launched to find the most compact shroud possible. The dominant contributor to the shroud length is the structure downstream of the turbine (the diffuser). This component has an ever increasing cross-section as one progresses downstream, however, fast rate of area divergence will cause flow separation and the significant reduction in output power associated with it. Ways to overcome this difficulty are discussed. This can be achieved either by proper diversion and introduction of the shroud's external flow into the diffuser's inner boundary layer or alternatively, by the usage of a ring-flap.

SITE CHARACTERISTICS

562 **Spacing of wind turbines in large arrays.** Newman, B.G. (McGill Univ., Montreal, Quebec). **16**: No. 4, 169-171(1977).

The effect of spacing on the power output of wind turbines in large arrays has been determined theoretically. Following Templin, the effect is assessed by determining the increase in roughness of the earth's boundary layer due to the drag of the turbines. The thickness of the boundary layer is assumed to change in proportion to the square root of the skin friction, which is appropriate for a turbulent Ekman layer, and differs from the assumptions made by Templin. The loss of power for both flat-open country and rough-wooded country is determined as a function of the area density of the turbines, and it is found that quite large spacings are required to avoid a significant loss of power.

ELECTRIC POWER ENGINEERING

REFER ALSO TO CITATION(S) 953, 1027, 1064

563 **Use of data processing installations for energy studies in interconnected systems.** Pozar, H. (Univ Zagreb, Yugosl). **30**: No. 1, 15-25(Jan 1977). (In German).

Operation studies relating to an interconnected system require a great amount of calculation work and data storage, for which data processing systems are indispensable. This need is accentuated where interconnected systems are treated which include both hydro and thermal generating plants. Difficulties arise even where the proportion of hydro energy in relation to the total generation is small, but the situation becomes still more complicated where storage and pumped storage exist in an interconnected system. The article describes methods which ave been developed at the Electricity Supply Industry Department and at the Electrical Engineering Faculty of the Zagreb University to solve problems of a nature described.

POWER PLANTS AND POWER GENERATION

REFER ALSO TO CITATION(S) 2, 9, 481, 1034

564 **Real-time power systems generation scheduling optimization.** Dopazo, J.F.; Ehrmann, S.T.; Sasson, A.M. (American Electric Power Service Corp., New York). pp 594-598 of In Modeling and simulation. Volume 7, Part 1. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P1.

Scheduling the generation of power plant units in real time to minimize cost of fuel in an interconnected system is not a solved problem. This is discussed in light of recent developments in power system observability through state estimation monitoring, current trends in fuel costs, and the schedule implementation process.

COOLING AND HEAT TRANSFER EQUIPMENT AND SYSTEMS

REFER ALSO TO CITATION(S) 1036

565 **Effect of heat transfer coefficient, local wet bulb temperature and droplet size distribution function on the thermal performance of sprays.** Chen, K.H.; Trezek, G.J. (Department of Mechanical Engineering, University of California, Berkeley, California). **99**: No. 3, 381-385(Aug 1977).

Energy balance considerations indicate that the droplet heat transfer coefficient, local wet bulb temperature, and droplet size distribution function are the basic parameters affecting spray system thermal performance. Within the range of available experimental data, results indicate that the Ranz-Marshall correlation gives an agreement to within +- 5.0 percent of measured droplet temperatures at the pond surface for a medium wind range of between 2.5 and 5 m/s. The local wet bulb temperature is taken as the arithmetic

mean of the initial and final wet bulb temperatures. For wind speeds greater than 3.5 m/s, the local wet bulb can be taken as the ambient. The modified log normal distribution of Mugele and Evans provides the best description of the droplet size distribution. Further, through the introduction of a correction term, the Spray Energy Release (SER) can be deduced from single droplet information.

566 Power plant including a cooling tower surrounding the power plant site. Kelp, F. (to Kraftwerk Union Aktiengesellschaft). US Patent 4,036,021. 19 Jul 1977. Priority date 9 Apr 1974, German, Federal Republic of (F.R. Germany). 6p.

A power plant, especially a nuclear power plant, is positioned within the interior of a double walled dry cooling tower, the cooling tower having its own foundation and encompassing the power plant site. The inner and outer walls of the cooling tower are adapted to form a relatively small ring zone as compared to the basis area of the power plant, the ring zone having a cooling air entrance at the lower end of the outer wall and an exit at its upper end. Within the ring zone, at its lower end, there are arranged cooling elements of heat exchangers, being exposed to the upwardly flowing cooling air stream. Through this arrangement the break in of cool winds or cool air, otherwise flowing reversely to the cooling air stream, from the exterior via the exit, is prevented.

567 Influence of building and supply conditions on coolant pumps and the various coolant pump designs for cooling towers. Holzhueter, E.; Migod, A.; Siekmann, H. (Klein, Schanzlin und Becker A.G., Frankenthal/Pfalz (Germany, F.R.)). **57**: No. 6, 414-424(Jun 1977). (In German).

36 figs.

This contribution tries to present the various factors influencing the design of cooling tower pumps. As cooling tower pumps are very often designed as concrete speral casing pumps, the suction bend construction often offers itself. The running wheel of cooling tower pumps is usually of semi-axial design, whereby one has to differ between rigid, adjustable, and resetable running wheels. Finally, the type of cooling system and the nominal width are decisive for either the construction type of the spiral casing pump or the tubular type pump. Both methods are compared in a critical way.

568 Structural problems in the construction of natural draught cooling towers. Zerna, W. (Bochum Univ. (Germany, F.R.). Inst. fuer Konstruktiven Ingenieurbau). **57**: No. 6, 430-434(Jun 1977). (In German).

8 figs.; 2 tabs.; 5 refs.

The paper deals with the structural requirements and development possibilities for large cooling towers, and in particular discusses parameter investigations into the reinforcement of cooling tower shells and problems of optimisation. In conclusion proposals are made as to how concrete cooling towers of very large dimensions reinforced with steel, as for example are required in dry cooling for large capacity plant, can be developed economically.

POWER CYCLES

REFER ALSO TO CITATION(S) 18, 1024

569 (EPA—600/2-76-212, pp 196-211) **Staged combustion in combined-cycle supplementary fired boilers.** Bartz, D.R.; Hunter, S.C.; Arand, J.K. (KVB, Inc., Tustin, CA). Aug 1976.

From Symposium on environment and energy conservation; Denver, Colorado, USA (3 Nov 1975).

In Symposium on environment and energy conservation.

A scaled laboratory combustion experiment was conducted to determine the effectiveness of staged combustion in reducing nitric oxide present in the combustion air supplied to large diffusion flames. Significant chemical reduction of the inlet nitric oxide suggests the possibility of application to supplementary fired combined-cycle systems as an alternative to water injection as a means of controlling NO/sub x/ to anticipated EPA emission limits.

570 (EPA—600/2-76-212, pp 249-267) **Energy conservation through the use of combined-cycle power systems.** Giramonti, A.J.; Blecher, W.A. (United Technologies Center, East Hartford, CT). Aug 1976.

From Symposium on environment and energy conservation; Denver, Colorado, USA (3 Nov 1975).

In Symposium on environment and energy conservation.

Analytical studies are being conducted to identify commercially feasible advanced technology combined-cycle power systems which would reduce consumption of fossil fuels, reduce utility-caused atmospheric and thermal water pollution, and produce low-cost electricity. Technological advances are described which could lead to gas turbines operating above 3,000°F and result in combined-cycle efficiencies approaching 55 percent (HHV) on clean gas or petroleum-based fuels. Because of the high cost and questionable availability of these fuels, the potential of combined-cycle systems using coal-derived fuels was established. One of the most attractive methods of utilizing coal would be to gasify it, remove the various pollutants, and burn the clean gas in a combined-cycle plant. Careful integration of the gasifier, cleanup, and power systems could result in coal burning power stations using presently available technology which would produce power at costs competitive with conventional steam plants using stack gas cleanup. These systems would also have comparable efficiency, reduced thermal pollution, and lower emissions of SO_2, NO/sub x/, and particulates. Systems utilizing advanced technology gas turbines would have even more attractive power costs, higher efficiency, and more favorable pollution characteristics.

571 (EPA—600/2-76-212, pp 311-319) **Balance-of-plant power requirements for advanced power systems.** Chait, I.L. (Burns and Roe, Inc., Hempstead, NY). Aug 1976.

From Symposium on environment and energy conservation; Denver, Colorado, USA (3 Nov 1975).

In Symposium on environment and energy conservation.

The growth in unit size of central station steam power plants in the last 20 years has been accompanied by a parallel and even more rapid growth in the auxiliary power required to operate the unit. From a nominal 4 to 6 percent of rating, onsite auxiliary power has steadily increased and, today, often takes 10 to 12 percent of the plant's output. The increases have resulted from a combination of environmental regulations and more severe operating conditions. Many proposed advanced power-conversion plants include, in addition to the usual auxiliaries, process equipment not found in today's plants. The power demand of all these auxiliaries may exceed the totals of present-day plants and must be included in determining the overall performance of advanced power systems—particularly when comparisons are made among such systems. To achieve the efficiencies and environmental acceptance desired, power plants using advanced power conversion systems—such as MHD generation, fuel cells, advanced steam and gas turbines in various combinations, fusion reactors, and solar collectors—are combined with topping and bottoming plants, which look very much like present-day plants. For equally cogent reasons, they are integrated with coal gasification and fuel-conditioning processes, cryogenic refrigeration, magnets, oxygen plants, scrubbing systems, seed recovery, and similar energy-consuming auxiliaries. The power load imposed by these additional processes may significantly reduce the overall plant thermal efficiency. From the viewpoint of energy and environment conservation, considerable benefit can be achieved by optimizing the balance-of-plant systems. Efforts for such improvements should proceed on parallel paths with, and at the same pace as, the efforts being made in developing the main advanced power-conversion systems.

COMPONENTS

REFER ALSO TO CITATION(S) 89, 95, 961

572 Heat exchange in a steam-generating pipe with internal ribbing. Grachev, N.S.; Kirillov, P.L.; Prokhorova, V.A. (Physics Power Institute). **14**: No. 6, 1105-1110(May 1977).

Results are presented of heat-exchange experiments carried out for a one-pipe model of a steam generator with internal helical ribbing. The pipe was heated by means of liquid sodium. It was discovered that in the boiling zone, beginning with x=0.15—0.20, a decrease in the heat-transfer coefficient takes place with an increasing thermal flux density. The internal ribbing, as compared to smooth pipes, permits a significant reduction in the length of the vaporizer and decreases the thermodynamic nonequilibrium in a two-phase flow.

573 Flame-scanning and burner-management systems on fossil-fuel steam generators. Longrigg, P. (Forney Engineering Co., Livingston, NJ). **50**: No. 4, 49-53(25 Apr 1977).

As New Zealand moves into fossil-fuel power generation and away from hydro-derived electricity, the importance of the boiler as a steam generator is evident. Present-day heat rates in the region of 8,000 kJ kWh^{-1}, compared with 12,000 kJ kWh^{-1} of a few years ago, are an example of the results achieved. However, in order to attain such results, these steam generators have assumed large proportions compared with their predecessors, and have become very complex and difficult to operate. Also quantities per unit time of the materials required to raise steam (fuel, combustion, air, and water), have grown to tremendous values, with the result that, when an abnormal condition occurs, the time available to take corrective action is decreased. Within the industry, there exists a general feeling that the above mentioned factors, and/or the possibility of human error, have contributed to a number of serious explosions that have occurred over the years in various parts of the world.

574 Transport mechanism of nonvolatile impurties in boiling on surfaces coated with a porous structure. Styrikovich, M.A.; Leont'ev, A.I.; Malyshenko, S.P. (High-Temperature Institute, Academy of Sciences of the USSR). **14**: No. 5, 886-893(Mar 1977).

The elementary processes responsible for impurity enrichment of the liquid in the immediate vicinity of the heating surface are

investigated in connection with boiling on a porous-coated surface. A simple theory is proposed for calculating the degree of impurity enrichment of the liquid on the surface. It turns out that the investigated effects can account for 10^2- to 10^3-fold enrichment, resulting in corrosion of the heating surface if surface-inactive impurities are corrosion-prone. These effects are a potential cause of recent steam generator accidents in a number of plants using PWR reactors.

575 On load washing of high pressure/temperature turbines. Sah, A.K.; Jain, R.K.; Bharadwaj, L.D. (Uttar Pradesh State Electr Board, India). **26**: No. 3, 12-19(Jul 1976).

Choking of flow sections of turbines often demands derating of the unit although boiler conditions permit full loading. A method whereby the turbine can be washed with saturated steam while on load is described. It also gives the details of application of this process on large capacity turbines in use at Harduaganj 'B' Power Station in Uttar Pradesh, India. The effects of variations in steam pressure/temperature on the boiler drum and turbine casing expansions as well as erosion in l-p blades are discussed. 8 refs.

WASTE HEAT UTILIZATION

576 (EPA—600/2-76-212, pp 191-195) **Waste heat utilization/reduction.** Christianson, A.G. (Environmental Protection Agency, Cincinnati); Cannon, D.J. Aug 1976.

From Symposium on environment and energy conservation; Denver, Colorado, USA (3 Nov 1975).

In Symposium on environment and energy conservation.

Projections indicate that waste heat rejection from central power stations in the year 2000 will nearly equal the total U. S. energy consumption in 1970. Although it is a waste product under our current methods of operation, a significant amount of this waste heat could be utilized. Three of the more promising options for waste heat utilization/reduction are (1) byproduct waste heat utilization, (2) byproduct electrical generation by industry, and (3) integrated energy production/use complexes. The implementation of these options could yield sizable short-term, midterm, and long-term environmental, economic, and energy conservation gains; however, because of the long lead times involved for planning, design, and construction of these facilities, work should be initiated on each of the options now. In order to successfully implement these options on a commercial scale, many technical, economic, and institutional problems must be overcome. The degree of success achieved will be dependent on the ability of energy producers, energy users, and government to mutually solve these problems.

ECONOMICS

REFER ALSO TO CITATION(S) 1029, 1031, 1033

577 (EPA—600/2-76-212, pp 60-68) **Effect of energy components on system costs and efficiency.** Thomas, T.J. (Battelle Columbus Labs., OH). Aug 1976.

From Symposium on environment and energy conservation; Denver, Colorado, USA (3 Nov 1975).

In Symposium on environment and energy conservation.

It is assumed that the cost and efficiency of proposed energy delivery system components must be evaluated within the context of the system with which they are to be used, as the system inefficiencies can scale up the costs of the proposed components. Specifically, there exists a number of technologies by which the sulfur oxide emissions from the burning of coal can be minimized. These technologies are attractive on paper, but their use may greatly affect total system cost and efficiency. A methodology is presented by which total system cost and efficiency may be easily calculated. Individual component contributions to total system cost and inefficiency are also developed by this methodology. This methodology is applied to six example energy delivery systems based upon the delivery of 1 MWe of electricity (from coal) to a midwest area. Each system has some form of sulfur removal, and each represents the most optimal system of a set of systems using nearly the same components in various combinations. The results show clearly the effect of major system components, including sulfur removal techniques, on total system cost and efficiency. Potential areas for improving system efficiency at little or no cost are delineated.

578 (EPA—600/2-76-212, pp 97-110) **Opportunities in electrical load management.** Bauer, D.C. (Federal Energy Administration, Washington, DC). Aug 1976.

From Symposium on environment and energy conservation; Denver, Colorado, USA (3 Nov 1975).

In Symposium on environment and energy conservation.

The importance of reliable and sufficient supplies of electricity in our economy, coupled with the substantial and increasing economic, energy, and environmental costs associated with its production, make it essential to insure that its development incorporates maximum practicable efficiencies. High among the underexploited opportunities for efficiency is load management and its complement, structural rate reform on the basis of long run marginal costs. The deterioration of load factors (average load/peak load) has aggravated financial stresses on the electric utility industry already burdened by inflationary pressures that have caused marginal costs to consumers to increase in constant dollars. Initial FEA modeling work projects that load management could have the effect of decreasing oil consumption by about 1.3 million barrels per day while maintaining a kilowatt-hour sales growth rate of about 5 percent/yr. Capital savings in plant expansion would be about $48 billion. From a fuels management point of view, increased reliance upon nuclear fuel and coal instead of oil and gas could be accomplished. Successive sections of the paper discuss the importance of structural rate changes including peak usage pricing, load management opportunities in space conditioning, heat storage, "cool storage," load deferrals, and load control options. The FEA utility program goals and features are described; these include a synopsis of demonstration projects in 7 states (recently expanded to another 12), the UCAN voluntary commitment program with the largest utilities, and invited regulatory interventions before local public service commissions.

OFF-PEAK ENERGY STORAGE

REFER ALSO TO CITATION(S) 513, 1057

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 970, 1369

NOXIOUS GAS AND PARTICULATE ABATEMENT AND CONTROL

REFER ALSO TO CITATION(S) 65, 66, 577, 971

579 Valuable products from high sulfur coal. Tavakoli Sabour, F. Chicago; Illinois Institute of Technology (1976). 193p. University Microfilms Order No. 77-13,763.

Thesis (Ph. D.).

A new process is designed for removing particulates and sulfur dioxide from the stack gas. For this purpose a pilot plant has been constructed with the capacity of 70 to 180 lb coal/hr. Two spray towers have been used for cleaning the stack gas in this pilot plant. Ammonia, potassium carbonate, and phosphate rock have been used as scrubbing agents. Ammonium phosphate, ammonium sulfate, and potassium sulfate are used as buffering agents. Absorption capacity of several buffering agents, and scrubbing agents were determined. In this process sulfur dioxide is recovered in the form of ammonium sulfate, potassium sulfate, calcium sulfate and sulfite. Calcium sulfate and sulfite is the reaction product of sulfur dioxide with phosphate rock. The rate and capacity for sulfur dioxide absorption mixture of water and phosphate rock were investigated. Some of the variables which effect the data, are particle size of the rock, and temperature and pH of the solution. Excellent results have been obtained for scrubbing of high sulfur coal (about 2.6% sulfur content) with ammonia or potassium carbonate. The maximum phosphate rock utilization for sulfur dioxide absorption is about 30% in the first tower, and considerably lower in the second tower. The results obtained thus far justify a recommendation that future studies include absorption using calcined rock. The same applies to the use of gaseous phase oxidation of sulfur dioxide. Also the use of acetone as an aid for sulfur dioxide hydrolysis of phosphate rock is recommended.

SITE SELECTION AND LAND USE

580 (ORNL/NUREG/TM—82) **System for regional analysis of water availability.** Jalbert, J.S.; Shepherd, A.D. 3 Oct 1976. Contract W-7405-ENG-26. vp. Dep. NTIS, PC A09/MF A01.

The Water Analysis System (WAS) has been developed in response to the high priority given water availability analysis in power plant siting. WAS is a composition of main programs and subroutines that process streamflow information from the United States Geological Survey (USGS) DAILY-VALUE water tapes, which contain data for all steam gaging stations in the United States. The WAS programs enable the user to (a) delimit any region of the United States by state, county, size of drainage area, or latitude-longitude frame; (b) recall daily flow values from the USGS water tapes for all gaging stations within the study region; (c) compute low flow recurrence frequencies and apply theoretical probability distributions; and (d) predict the reservoir drawdown capacity necessary to maintain any given rate of streamflow at any specified rate of consumption. The WAS procedure provides a valuable tool for energy facility siting in particular and is directly applicable to many water resource questions.

POWER TRANSMISSION AND DISTRIBUTION

REFER ALSO TO CITATION(S) 1024

581 (AD-A—039638) **FAA lightning protection study: lightning-induced transients on buried shielded transmission lines. Final report Jun 1974—Jun 1975.** Nordgard, J.D.; Chen, C. Jun 1975. Contract DOT-FA72WAI-356. 71p. NTIS PC A04/MF A01.

An analysis of induced transient current and voltage pulses on buried shielded transmission lines, due to earth conduction effects of nearby lightning discharges is presented. Two basic analytical methods are presented to describe the various kinds of coupling mechanisms between a lightning discharge to ground and an earth-return transmission line. The transmission line is assumed to be a long straight horizontal coaxial cable with an inner shield and an outer armor, terminated on both ends with typical communication equipment load impedances. The general case is considered in which the outermost conductor is not necessarily in perfect contact with the conducting earth but as a contact impedance with the earth, as in cables with an outer dielectric covering for corrosion or water protection. Both direct strikes to the cable via arcing from the terminal ground point of the lightning channel to the outer conductor of the coaxial cable and indirect strikes to the cable via conductive coupling mechanisms through the earth are considered.

582 (EPA—600/2-76-212, pp 212-216) **Electric power transmission modes, means, and style.** Flugum, R.W. (Energy Research and Development Administration, Washington, DC). Aug 1976.

From Symposium on environment and energy conservation; Denver, Colorado, USA (3 Nov 1975).

In Symposium on environment and energy conservation.

Transmission of electric power faces a challenge in the future as the Nation shifts to a more electric economy to conserve scarce fossil fuels. The modes of transmission must be expanded in power transfer capability, and environmental aspects and efficiency must be considered as essential elements in design and installation practices.

583 (EPRI-TD—172) **High-voltage transmission conductor motion research. Final report.** Rawlins, C.B. Jun 1976. 206p. Dep. NTIS, PC A10/MF A01.

Research on wake-induced oscillation of bundled conductors performed to develop the technoogy required for design of bundle lines and for alteration of existing lines to prevent the oscillations is described. The investigation to date has encompassed a program of measurements of oscillation behavior of existing lines, measurements of turbulence of natural winds to which the lines are exposed, wind tunnel measurements of aerodynamic characteristics of conductors in bundles, and development of theoretical and computer analyses for predicting conditions under which actual spans may oscillate. The computer analyses used with the wind tunnel data developed in the program, provide a useful tool for predicting the effectiveness of devices and procedures intended to prevent oscillation. The influence of local terrain is taken into account. Comparison of predictions based on the computer analyses with measured behavior of actual field spans is satisfactory in the cases where comparison is possible. The number of such cases is limited by the range of the wind tunnel data that must be used with the computer analyses. Continuation of the program to expand the range of wind tunnel data, and to broaden the array of field test data to permit more thorough validation of the analyses, is recommended.

584 Distribution transformer tests under load reported. 55: No. 4, 40-41(Apr 1977).

A representative sample of 54 commercial distribution transformers with a 15-kV class insulation system was taken from utility stockpiles and subjected to full wave impulse voltages at load currents ranging from 0 to 175 percent of rating. Twenty-eight of the 54 units in the sample were unaged. Units were tested both in a dry condition and during a wet phase of simulated rain. Analysis of the test data shows clearly that impulse strength decreases as operating temperatures increase. In addition the thermal design characteristics greatly affected the relationship between impulse strength and load current. A comparison of core type versus shell type showed that unaged core-type units were on the average 40 percent higher in impulse strength than unaged shell type units. However, the difference between the two types decreased to only 20 percent after both were aged to half-life.

585 Transient performance of superconductive energy storage units in electric power systems. Winkelman, J.R. Madison, WI; Univ. of Wisconsin (1976). 146p. University Microfilms Order No. 77-8126.

Thesis (Ph. D.).

The possibility of using large superconductive inductors for energy storage purposes in electric power systems has been under study since the beginning of the 1970's. The technical feasibility of the concept has been shown, and when "credits" assignable to energy storage (transmission, pollution control, and spinning reserve) are properly evaluated, cost competitiveness should be achievable. Electrical system studies have been mainly concerned with disturbances which are electromechanical in nature. This study analyzes electrical transient performance of superconductive energy storage units in electric power systems. The basic problem investigated is as follows: Assume a system where the sending end and receiving end are separated by a transmission line of length l which is loaded to some practical level, say surge impedance loading. A disturbance occurs somewhere in the load area and this load is dumped by opening a circuit breaker at the receiver end low voltage terminals. The interaction of the resultant oscillating system and a storage unit is investigated thoroughly. Qualitative results are obtained by digital simulation and computer results are checked with analytical methods and with miniature network simulator verification where possible. The significant results contained in this thesis are: ac/dc converters can operate under transient conditions with a constraint of constant current being imposed by the superconductive inductor; superconductive energy storage units can reduce peak transient overvoltages if a proper control scheme is used; the control action required to produce the minimum overvoltage also serves to minimize overspeeding by reducing the new accelerating torque at the sending end generator following the loss of load; and superconductive energy storage units may also be used to limit steady-state voltages at its terminals.

586 Sensitivity analysis of optimal regulators with application to large-scale power systems. Darwish, M.; Delacour, J.D.; Fantin, J. (CNRS, Toulouse). pp 894-897 of In Modeling and simulation. Volume 7, Part 2. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P2.

The determination of the values of optimal regulator parameters was investigated. The control is chosen in such a way as to minimize a certain cost function, while choosing the system controllable parameters in the region of low sensitivities. This technique is applied to large-scale power systems and multiparameters sensitivity analysis is used for the selection of the parameters of the voltage and speed regulators.

AC SYSTEMS, EHV AND UHV

587 Numerical analysis of convective cooling of pipe-type electric cables. Chern, S.Y. Urbana, IL; Univ. of Chicago (1977). 132p. University Microfilms Order No. 77-14,936.

Thesis (Ph. D.).

A numerical analysis is developed for predicting friction factors and heat transfer coefficients in pipes with irregular cross-sections such as those occurring in underground pipe-type electric cable systems. The method is to find three-dimensional temperature and velocity fields in laminar flow for three different cable configurations. The secondary flow generated by natural convection becomes very important for this system. Thus, the Nusselt number is strongly dependent on Rayleigh number and cable configuration, both of which affect the secondary flow. The analysis employs the finite element method which can be easily applied to irregular geometries and non-uniform meshes. The numerical solutions substantially agree with experimental results. They show that the Nusselt number increases with increasing the Rayleigh numbers, and that increasing the Rayleigh number decreases the thermal entrance length. The results also determine how the Nusselt number is affected by cable configurations. The friction factors are essentially independent of the natural circulation and depend only on the Reynolds number and the configuration. For each configuration f-Re is a different constant. The calculated constants are somewhat lower than the experimental data. This is due, primarily, to the presence of skid wires in the experiments, which are not taken into account explicitly in the analysis.

588 Modeling the national bulk electric power transmission system. Fegley, K.A. (Univ. of Pennsylvania, Philadelphia). pp 943-947 of In Modeling and simulation. Volume 7, Part 2. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P2.

This nation's bulk electric power is transferred via many thousands of miles of high voltage transmission lines. Each year brings new lines into the system. A series of models, used in sequence in an algorithmic procedure, provides a means for determining the additions which should be made to this bulk power transfer system.

SUPERCONDUCTING AND CRYOGENIC SYSTEMS

589 (EPRI-EL—402(Vol.2)) **Superconducting cable system. Volume II. Final report.** Meyerhoff, R.; Morihara, H. May 1977. Contract EX-76-C-01-1420. 365p. Dep. NTIS, PC A16/MF A01.

The following appendices to a final research report on a proposed superconducting cable system for ac power transmission are included: technical background of the cryogenic envelope and refrigeration system; method for calculating envelope heat leak; construction procedures and costs for the installation of superconducting cable systems; cost estimate summaries and worksheets;construction schedule;production of Nb—Cu—Invar composite conductor; and development of superconducting cable termination and its epoxy bushing. (LCL)

590 **Partial discharge in liquid nitrogen.** Kosaki, M.; Hane, Y.; Isaka, S.; Horii, K. (Nagoya Univ., Japan). **96**: No. 4, 1-7(1976).

Translated from Denki Gakkai Ronbunshi; 96A: No. 7, 317-324(Jul 1976).

Results are presented of experiments on partial discharge in liquid nitrogen, including insulation breakdown characteristics of liquid nitrogen, partial discharge characteristics of composite insulation systems, lifetime of polymer films, impulse breakdown of polymer films in liquid nitrogen, etc. The partial discharge characteristics of liquid nitrogen are examined with increasing liquid-nitrogen pressure. It is concluded that a composite insulation structure of polymer film and liquid nitrogen can be used as effective electrical insulators at cryogenic temperatures.

NUCLEAR POWER PLANTS

REFER ALSO TO CITATION(S) 953, 984, 1041

591 **Salzburg conference - technical notes. Highlights from technical sessions at the IAEA conference on nuclear power and its fuel cycle are recorded.** Cave, L. (Pollution Prevention (Consultants) Ltd., Crawley (UK)); Kovan, R.; Marshall, P. **22**: No. 259, 33-36(Jul 1977).

Highlights are recorded from the IAEA Conference on Nuclear Power and Its Fuel Cycle, held at Salzburg. They relate chiefly to fast reactor policies, views on special types of fuel cycle, various aspects of fast reactor safety, and reprocessing progress in Europe.

592 **Zagreb's floating plant design offers alternative siting possibilities.** Sladoliev, Z. (Zagreb Univ. (Yugoslavia)). **22**: No. 259, 32-33(Jul 1977).

A team of experts at the Faculty of Mechanical Engineering and Naval Architecture, University Of Zagreb, are applying the logic and experience gained in designing semisubmersible drilling rigs to design standardized semisubmersible nuclear plant. A brief description of the concept is given.

593 **Nuclear energy in the Netherlands.** Uitham, K.T.; de Vries, H.J.M.; Zijlstra, G.J. **12**: No. 2, 161-206(Apr 1977). (In Dutch).

An extensive survey is presented of the national activities concerning nuclear energy in the Netherlands. Factors influencing the policy-making are elucidated. A special graphical technique is used to reveal the organisational interrelationships between important industrial firms, their directors and board members, research institutions and governmental departments. This so-called network analysis indicates that the examined relationships are relationships of influences exercised on the nuclear energy policy-making.

594 **Nuclear power plant without cooling towers combined with a pumped storage facility.** Haenni, H. (Eidgenoessische Technische Hochschule, Zurich (Switzerland)). **22**: No. 3, 146-149(Mar 1977). (In German).

2 tabs.; 17 refs.

In meeting the load requirements of the power grid it is very advantageous to combine a thermal power plant with a hydroelectric plant to cover peak loads. The report deals with a nuclear power plant combined with a pumped storage plant with two pools as the cooling and storage pools. This installation would not even need cooling towers, because of the extensive use made of the waste heat for agricultural application, hot water preparation, etc. The heated cooling water is collected downstream of the condenser and passed through various greenhouses, swimming pools, floor heating systems etc., cooled on its way and passed on to the other pool, where it is returned to the condenser of the nuclear power plant for cooling purposes. This concept, which is suggested as a basis for discussion, not only offers advantages in terms of ecology and energy utilization, but also represents a major strategic safety item in energy supply in case of war.

595 **New nuclear power stations in the Federal Republic of Germany. Part 1 of the report on building schemes and projects in Europe 1977. 22**: No. 3, 118-133(Mar 1977). (In German).

16 figs.; 3 tabs.

A survey is presented of all nuclear power plants in the FRG which are either in operation, under construction or in the stage of planning. In this context, a compilation in tabular form and a short review of the various reactors supplement each other. The data presented is in the main the result of an inquiry by ATW with public utilities and reactor building firms.

596 **Simulator training of nuclear power plant personnel at the Kraftwerksschule e.V.** Schlegel, G. (Kraftwerksschule e.V., Essen (Germany, F.R.)). **6**: No. 3, 89-91(Mar 1977). (In German).

3 figs.; 4 tabs.; 4 refs.

The 'Kraftwerksschule e.V.' in Essen, a joint organization by the operators of power plants, is building a training centre with two nuclear power plant simulators which will start operation in the second half of 1977. The article deals with the reasons for embarking upon simulator training, describes the design and the mode of functioning of a simulator, and portrays the kind of training envisaged.

597 **Energy system with nuclear power stations for the generation of public current and of hydrogen from the electrolysis of water.** Foerster, S.; Hewing, G.; Sack, B. **29**: No. 2, 59-65(Feb 1977). (In German).

10 figs.; 4 tabs.; 4 refs.

The article describes a large system for the generation of public current and of hydrogen from the electrolysis of water, based on nuclear power stations. Full-load operation of the nuclear power stations and intermediate storage of the hydrogen produced are essential for the operation of the system. Starting with an estimation of the power stations output to be installed in a system for the Federal Republic of Germany in the year 2,000, the method of constructing the system from basic units is described. The outstanding specific characteristics, such as method of operation, safety, energy conversion and economics, are shown for nuclear power stations of the presently operating and advanced designs, as well as for electrolysis techniques tested today. The storage of hydrogen is also included. The possibilities of realising the system and of a representative demonstration plant are outlined.

598 **Energy policy and the role of nuclear power.** Brookes, L.G. (UKAEA). pp 2.1-2.11 of In Proceedings of symposium on energy in the 80s. London; Institution of Chemical Engineers (1977).

From Symposium on energy in the 80s; Middlesborough, UK (5 - 7 Apr 1977).

It is shown that sharply increased oil prices have harmed GNP performance and severely reduced the rate of substitution of nuclear for fossil energy. Reduction or stabilization of energy prices should be the primary objective of energy policy. It is suggested that the UK could help to maintain economic momentum by making the maximum use of gas while exporting oil. The taxes and royalties from the oil might best be fed back into the economy by reducing other forms of taxation. The complex interaction of the costs and prices of different fuels is discussed. The role of nuclear energy is considered. It is concluded that it is the cheapest, safest and cleanest way of producing electricity, and it is suggested that it should be bound up with the exploitation of the fast breeder reactor. The role of coal and of the Middle East oil reserves themselves is also considered.

599 **Government energy policies.** Cunningham, J.A. (Department of Energy, London (UK)). pp 1.1-1.12 of In Proceedings of symposium on energy in the 80s. London; Institution of Chemical Engineers (1977).

From Symposium on energy in the 80s; Middlesborough, UK (5 - 7 Apr 1977).

The changing pattern of UK primary supplies, domestic and imported, over the period 1950 to 1990, is shown. UK energy resources are discussed under the headings: coal, gas, oil, nuclear, conservation, and renewable sources (e.g. wave energy, geothermal, solar). The further development of UK energy policy is then considered, with particular reference to nuclear energy. The arguments for and against the use - or greater use - of nuclear energy, and the relative positions of thermal and fast reactors, are referred to.

600 **Elements of reactor system design. Chapter 1.** Weisman, J. (Cincinnati Univ., Ohio (USA). Dept. of Chemical and Nuclear Engineering). pp 1-19 of In Elements of nuclear reactor design. Weisman, J. (ed.) (Cincinnati Univ., Ohio (USA). Dept. of Chemical and Nuclear Engineering). Amsterdam, Netherlands; Elsevier (1977).

The author describes the wide variety of possible power reactor types, and points out the common features of the systems, e.g. the reactor core, fuel elements, primary coolant system, primary containment, reactor control system, power generating systems, and safety systems.

601 Method for clarifying waste water and optional additional treatment of seawater with simultaneous utilization of waste heat e.g. from nuclear power plants. Borst, A.H. German(FRG) Patent 2,519,887/A/. 11 Nov 1976. 8p. (In German).

4 figs.

It is proposed to utilize the waste heat of nuclear power plants for heating a plant to clarify waste water. The method provides for passing the waste water through a heatable channel into which carriers of fertile soil can be sunk exchangeably, contributing to food and feed production by intensive plant growth. The insertion of fertile soil carriers is described in detail. Simultaneous treatment of sea water shall be possible.

602 Studies and thoughts about nuclear systems. Grenon, M. **27**: No. 288, 541-548(Nov 1976). (In French).

The French position concerning the opportunity of developing other reactor types between LWR and LMFBR reactors is recalled. The results of the Battelle report about the problem of intermediate or alternative types are analyzed. On the basis of data available for LWR and LMFBR reactors several types are compared (HTGR, MSBR, CGFR, LWBR, CANDU) according to various nuclear development scenarios.

603 Cooperation with the Soviet Union in the development of the fuel and power base and in the implementation of the nuclear programme in Czechoslovakia. Harvanek, Z. **22**: No. 11, 401-403(Nov 1976). (In Czech).

One of the decisive chapters of the long-term programme of international cooperation with the Soviet Union is the solution of the problems of the development of the Czechoslovak fuel and power base, i.e., by the implementation of the nuclear programme. Cooperation in the solution of these tasks is oriented to the following spheres of activity: the realization of and cooperation in research and development tasks, the implementation of project designs based on basic and applied research, and cooperation in the production and assembly of technological equipment for nuclear power production.

604 Nuclear power stations in Switzerland, 1975. 68: No. 41, 1034-1035(12 Oct 1976). (In German, French).

A short summary of the 1975 annual report of the Swiss Association for Atomic Energy is presented.

605 Comments on the energy crises of the USA. Pt. 2. Wolf, P.C. **82**: No. 5, 97-102(Oct 1976). (In German).

8 figs.; 2 tabs.

Various alternatives to reduce the energy crisis, up to the radical solution of 'zero-growth' are now under discussion and the consequences are being discussed in Congress and in the press of the USA. For the next 30 to 50 years, the USA economy will be based mainly on fossil fuels. A development of the plants for coal liquefaction is necessary within the next 10 years. An increased use of breeder reactors is necessary in order to stretch the existing uranium reserves. Research and development in the field of nuclear fusion should be accelerated especially regarding the generation of cheap hydrogen by electrolysis of sea-water. Increased use of geothermal and solar energy, as well as of water and wind power could support the energy programme.

606 Operation of nuclear power stations during 1975. Luxembourg; European Communities. Statistical Office (Aug 1976). 65p. (In English, French).

In 1975, the production of nuclear energy in the Community of the Nine was 77 thousand million net kWh, an increase of 26.5% over 1974. A short commentary explains this large increase and the situation in each country is briefly reviewed. Then data on the evolution of net production (partitioned according to reactor family), on the availability of reactor types according to their age, and on the structure of nuclear plants (situation at the end of 1975) are presented. The statistical data of annual operation are given for each reactor.

607 Optimization of operating regimes of power systems with nuclear power plants. Zaviska, O. (Elektromontazni Zavody, Prague (Czechoslovakia)). **26**: No. 10, 451-454(1976). (In Czech).

A method is presented of the optimization of operating regimes of nuclear power plants permitting the optimization of short- and long-term operating regimes of the plants by simple means. The basic data for determining the consumption characteristics and various restrictions in the campaign are the results of calculations of burnup, the negative effects of reactivity, changes in the coefficients of power non-uniformity, etc. The results make it possible to determine the permissible changes in nuclear power plant loading at any arbitrary moment of the campaign and to correct the optimal operating regime of the plant accordingly.

608 Nuclear power development and the fuel cycle. Farmakes, R. (ed.). Hinsdale, IL; American Nuclear Society, Inc. (1976). 600p. (CONF-761014—).

From 1. Pacific Basin topical conference on nuclear development and the fuel cycle; Honolulu, Hawaii, United States of America (USA) (11 Oct 1976).

Included are thirty-six papers, each of which has been separately processed for the Energy Data Base; four additional papers were processed previously. All of the thirty-six items were selected for Energy Research Abstracts (ERA), and eleven for Energy Abstracts for Policy Analysis (EAPA). (DG)

609 Energy Research and Development Administration's nuclear program. Roberts, R.W. (Energy Research and Development Administration, Washington, DC). pp 15-22 of In Nuclear power development and the fuel cycle. Farmakes, R. (ed.). Hinsdale, IL; American Nuclear Society, Inc. (1976).

From 1. Pacific Basin topical conference on nuclear development and the fuel cycle; Honolulu, Hawaii, United States of America (USA) (11 Oct 1976).

See CONF-761014—.

Brief comments are presented on the role envisaged by ERDA for nuclear power in meeting U.S. energy needs over the next several decades. Included are comments on nuclear power growth projections, fuel cycle economics, and radioactive waste disposal. (DG)

610 Development of the Canadian nuclear power program. Leaist, G.T. (Atomic Energy of Canada Ltd., Ottawa). pp 23-42 of In Nuclear power development and the fuel cycle. Farmakes, R. (ed.). Hinsdale, IL; American Nuclear Society, Inc. (1976).

From 1. Pacific Basin topical conference on nuclear development and the fuel cycle; Honolulu, Hawaii, United States of America (USA) (11 Oct 1976).

See CONF-761014—.

The history of the CANDU reactor system is briefly reviewed with particular emphasis on factors contributing to the successful commercial application of the system. Foremost among these factors is the close integration of effort among industry, electrical generating utilities, and development laboratories. The present status of the program is reported and the direction of related research and development programs indicated. These programs support the present generation of power reactors and develop advanced concepts to enable the best use of domestic resources under circumstances that may prevail at the end of the century. Of particular interest is the development of an economic fuel cycle that is relatively insensitive to uranium prices, involves relatively modest evolutionary development of the CANDU reactor system, and assures adequate fuel supplies for CANDU reactors far into the future.

611 First steps toward a nuclear power program: the Indonesian experience and prospects. Baiquni, A.; Sudarsono, B. (National Atomic Energy Agency, Djakarta, Indonesia). pp 43-52 of In Nuclear power development and the fuel cycle. Farmakes, R. (ed.). Hinsdale, IL; American Nuclear Society, Inc. (1976).

From 1. Pacific Basin topical conference on nuclear development and the fuel cycle; Honolulu, Hawaii, United States of America (USA) (11 Oct 1976).

See CONF-761014—.

The paper describes the experiences leading to formulation of a national energy policy and nuclear power program which is still in evolution in Indonesia. Beginning with developments in the early 1960's, the overall energy picture and the most recent trends are discussed. A brief description of plans in nuclear technology development is given.

612 Nuclear power generation in Japan. Toyota, M.; Sasaki, S. (Tokyo Electric Power Co., Inc.). pp 53-75 of In Nuclear power development and the fuel cycle. Farmakes, R. (ed.). Hinsdale, IL; American Nuclear Society, Inc. (1976).

From 1. Pacific Basin topical conference on nuclear development and the fuel cycle; Honolulu, Hawaii, United States of America (USA) (11 Oct 1976).

See CONF-761014—.

The following topics are addressed: (1) historical background and nuclear power development highlights; (2) present status and development plans for nuclear power generation; (3) major construction, operation, and maintenance problems; and (4) safety and public relations. (DG)

613 Nuclear power program in Korea. Lee, H. (Korea Atomic Energy Research Inst., Seoul). pp 77-92 of In Nuclear power development and the fuel cycle. Farmakes, R. (ed.). Hinsdale, IL; American Nuclear Society, Inc. (1976).

From 1. Pacific Basin topical conference on nuclear development and the fuel cycle; Honolulu, Hawaii, United States of America (USA) (11 Oct 1976).

See CONF-761014—.

The present status of nuclear power development in Korea is presented. Brief descriptions of the projected power requirement with nuclear share and nuclear power/fuel cycle technology development plans are introduced. Common problem areas through

Korea's nuclear experience are reported and constructive proposals are made. A developing country on the verge of entering the nuclear age should place the utmost priority in establishing a manpower development program and quality assurance system for securing safe and reliable products. International exchange of technical data among nuclear importing countries is proposed for mutual benefit.

614 Effects of underdevelopment on developing nuclear power. Eibenschutz, J. (Comision de Energeticos, Mexico City); Sefchovich, E. pp 93-100 of In Nuclear power development and the fuel cycle. Farmakes, R. (ed.). Hinsdale, IL; American Nuclear Society, Inc. (1976).

From 1. Pacific Basin topical conference on nuclear development and the fuel cycle; Honolulu, Hawaii, United States of America (USA) (11 Oct 1976).

See CONF-761014—.

A brief global view is presented of the implications of and the prospects for developing a substantial nuclear program in Mexico. Such a program envisions a rather ambitious approach in that it contemplates not only construction and operation of an appreciable number of power plants but, in addition, the development of the necessary fuel-cycle industries and services, the gradual integration of national industry to the manufacture of components for nuclear power plants, and an increasing domestic contribution to the engineering and construction of the plants. Many difficulties must be overcome to achieve the goals of the program. Financing of the power plants alone is a major problem in itself. Moreover, there are many technical problems to be solved before production of anything can start: e.g., although appreciable uranium deposits are expected, these must be found and analyzed before their economic viability can be established. In addition, time is of the utmost importance. Nevertheless, it is felt that these problems can be solved once a national commitment is made to the program. Although precious time has been lost, and achieving 15,000 MW of installed nuclear capacity by 1990 looks more remote every passing day, it is believed that if proper institutional and structural decisions are made shortly, prospects for success are good. Moreover, the great benefits that would accrue to the nation from the program certainly make a vigorous effort worthwhile. (Conclusions).l

615 Development of the nuclear power program of the Philippines. Ibe, L.D.; Corpus, G.C. (Philippine Atomic Energy Commission, Quezon City). pp 101-115 of In Nuclear power development and the fuel cycle. Farmakes, R. (ed.). Hinsdale, IL; American Nuclear Society, Inc. (1976).

From 1. Pacific Basin topical conference on nuclear development and the fuel cycle; Honolulu, Hawaii, United States of America (USA) (11 Oct 1976).

See CONF-761014—.

In 1958, Republic Act 2067, referred to as the Philippine Science Act of 1958, was enacted into law. This Act created, among other things, the Philippine Atomic Energy Commission (PAEC) as the principal agency responsible for the promotion of atomic energy for peaceful purposes. The idea of the Philippine Government in creating PAEC was to develop the country's capability in nuclear and reactor technology to meet anticipated manpower needs in large-scale application of nuclear energy for the production of electrical energy. The national demand for electric power and energy was then increasing steadily with the growth in industry, in economic activities, in population, and with the improvement of the standard of living of the Filipino people. The PAEC acquired a 1-MW nuclear research reactor and envisioned it to serve as the starting nucleus of the nuclear power program. Through its installation and subsequent operation, it aimed to attract the interest of engineers and technologists to the nuclear field, while simultaneously building its capability to undertake research on atomic energy and radioisotope applications.

616 Developing a national nuclear power program in Taiwan, Republic of China. Chu, D.S.L. (Taiwan Power Co., Taipei). pp 117-131 of In Nuclear power development and the fuel cycle. Farmakes, R. (ed.). Hinsdale, IL; American Nuclear Society, Inc. (1976).

From 1. Pacific Basin topical conference on nuclear development and the fuel cycle; Honolulu, Hawaii, United States of America (USA) (11 Oct 1976).

See CONF-761014—.

Taiwan is greatly committed to nuclear power for its future energy supply. The Taiwan Power Company, as the sole power utility in Taiwan, is charged with the responsibility of carrying out this important nuclear power program. The energy situation in Taiwan and how it led to the choice of nuclear power as an important energy source is described. Six nuclear units are currently under construction in Taiwan. They are expected to be in commercial operation in 1977, 1978, 1980, 1981, 1983, and 1984, respectively. By the end of 1985, the nuclear units will generate 50% of Taiwan's electrical energy.

617 Managing nuclear plant standardization. Morowski, J.V. (Bechtel Power Corp., Los Angeles, CA). pp 133-142 of In Nuclear power development and the fuel cycle. Farmakes, R. (ed.). Hinsdale, IL; American Nuclear Society, Inc. (1976).

From 1. Pacific Basin topical conference on nuclear development and the fuel cycle; Honolulu, Hawaii, United States of America (USA) (11 Oct 1976).

See CONF-761014—.

Development of a national nuclear program must take into account the issue of standardization because the approaches to standardization in the design and construction of a nuclear power plant are complex and challenging problems. In an effort to shorten licensing, design, and construction schedules and reduce costs, four methods of design standardization have been proposed by the U.S. Nuclear Regulatory Commission. Each of the methods has its inherent limitations and restrictions, and other methods should be considered. A generic approach coupled with effective overall project management that emphasizes clearly defined criteria key design documents and modular plant arrangements offers a logical approach to standardization.

618 Reliability analysis: its value to the nuclear industry. Draper, O.L. (General Electric Co., Sunnyvale, CA). pp 1083-1086 of In Modeling and simulation. Volume 7, Part 2. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P2.

Reliability Analysis includes the planning, organization, and execution of those engineering activities which are necessary to determine the probability of successfully performing a given function in a given environment for a stated period of time. The implementation of these principles and disciplines in the commercial business of power generation will enhance the safety and reduce the cost of the nuclear power plant.

619 Shutdown system reliability duty cycle. El-Bassioni, A.A. (Carnegie-Mellon Univ., Pittsburgh); Baloh, F.J.; Horton, W.H. II. pp 1087-1091 of In Modeling and simulation. Volume 7, Part 2. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P2.

A method for generating a Shutdown System Reliability Duty Cycle is derived. Analyses of the events comprising the "Reliability Duty Cycle" are oriented to confirm reactor shutdown system reliability goals and to check the depth of the system design defense against common mode failure.

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, BOILING WATER COOLED

REFER ALSO TO CITATION(S) 840, 842, 843, 846, 848, 863, 864, 865

620 (EPRI-NP—339) **Improved evaluation of nozzle corner cracking. Final report.** Cohen, L.M.; McLean, J.L.; Moy, G.; Besuner, P.M. Mar 1977. 304p. Dep. NTIS, PC A13/MF A01.

Within the past few years flaws have been discovered at the inside corners of feedwater nozzles of several operating boiling water reactors. The significance of these flaws has been evaluated for structural safety using linear elastic fracture mechanics. The evaluations have been based on stress intensity factors, K(a), which were obtained for a single flaw location and pressure loading only. Conservative assumptions were made to account for other flaw locations and the effect of thermal stresses. The report provides stress intensity factors for fifteen postulated corner flaw locations in a typical feedwater nozzle subjected to pressure and thermal stresses, and considers the effect of a residual stress caused by the weld-deposited cladding. The use of these data permits more accurate fracture mechanics evaluations of nozzle corner flaws.

621 Evaluating the performance of in-service inspectors. Reinhart, E.R. 2: No. 6, 61-65(Aug 1977).

A study to evaluate current practice for inservice inspection of reactor piping and pipe welds is described. BWR bypass and core spray lines containing stress corrosion cracks were inspected by five groups that provide inspection services to the industry. Their results were compared with detailed laboratory examinations of the same pipe specimens. This comparison provided insight into the factors affecting inservice inspection performance and helped to establish a baseline on which to build future work on improved techniques.

622 Plate type nuclear fuel element and a method of fabrication of said element. Bergougnoux, R.; Delafosse, J. (to Commissariat a l'Energie Atomique). US Patent 4,038,135. 26 Jul 1977. Priority date 6 Jul 1973, France. 8p.

The fuel element comprises a core having a base of ceramic fuel material enclosed between two metallic cladding plates and constituted by the juxtaposed array of a plurality of ceramic fuel wafers. At least a number of wafers are provided with individual metallic protection which performs a contributory function in the cladding of the wafers and in the division of the fuel element into compartments.

623 Locking means for fuels bundles. Pugh, R.A. (to Exxon Nuclear Company, Inc.). US Patent 4,038,137. 26 Jul 1977. Filed date 3 Nov 1975. 6p.

A nuclear power reactor fuel bundle is described which has a plurality of fuel rods disposed between two end plates positioned by tie rods extending therebetween. The assembled bundle is secured by one or more locking forks which pass through slots in the tie rod ends. Springs mounted on the fuel rods and tie rods are compressed by assembling the bundle and forcing one end plate against the locking fork to maintain the fuel rods and tie rods in position between the end plates. Downward pressure on the end plate permits removal of the locking fork so that the end plates may be removed, thus giving access to the fuel rods. This construction facilitates disassembly of an irradiated fuel bundle under water.

624 Portable digital reactivity meter for power reactors. Steffen, G. (Nuklear-Ingenieur Service G.m.b.H., Hanau (Germany, F.R.)). **19**: No. 7, 327-332(Jul 1977). (In German, English).

4 figs.; 7 refs.

A digital reactivity meter has been developed, which can be used for all kinds of kinetic reactivity measurements in PWR's and BWR's. The input signals may be supplied by standard neutron detectors of the reactor. The hardware configuration consists of a minicomputer with ADC and DAC, a 'Silent' terminal and a high speed paper tape reader/punch. It is easily transportable. The reactivity meter solves the inverse kinetics equations for 6 delayed neutron groups, simultaneously for up to 8 logarithmic or linear neutron flux signals. It has been successfully tested at Biblis A PWR and the KRB BWR.

625 Sweden proves that small country can build big pressure vessels. Hultkrantz, B.; Jonnerby, E. (Uddcomb Sweden AB). **22**: No. 259, 53-56(Jul 1977).

A description is given of developments in fabrication of nuclear pressure vessels in Sweden. Inspection, overlay welding methods and stress analysis are discussed.

626 Designers can solve materials problems in nuclear technology. Oestberg, G. **8**: No. 6, 177-181(Jun 1977).

8 figs.; 7 refs.

Materials problems in nuclear power stations can rarely be dealt with independently of design, maintenance, including operation, inspection and control as well as environmental factors. Therefore they require combined efforts of designers and materials specialists. The paper illustrates this by examples of some current developments of light-water reactors: tubing in condensers and steam generators in PWR, primary piping in BWR, pressure vessels and fuel elements. Keywords in the development of materials engineering and technology in this field are reliability and safety through quality assurance, rather than increased efficiency and performance data.

627 Bonding between UO_2 fuel and zircaloy-2 cladding. Romeo, G.; Wolff, U.E. (General Electric Co., Pleasanton, CA). **26**: 213(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

628 Utility needs for codes to perform reactor physics and core follow work. Pilat, E.E. (Yankee Atomic Electric Co., Westboro, MA); Flournoy, W.G.; Cobb, W.R. **26**: 219(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

629 Utility needs for fuel rod modeling capability. Meyer, J.E. (Massachusetts Inst. of Tech., Cambridge); Hanson, A.S.; Pitek, M.T.; Schultz, S.P. **26**: 219-220(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

630 Effect of thermal diffusion from fuel pellets on rewetting of overheated water reactor pins. Pearson, K.G. (UKAEA Reactor Group, Winfrith. Atomic Energy Establishment); Piggott, B.D.G.; Duffey, R.B. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). **41**: No. 2, 165-173(Apr 1977).

The paper presents the results of a finite difference solution of a conduction equation for the rewetting of a hot tube containing a filler material. The results show that the effect of a filler is always to reduce the rewetting velocity compared with an empty tube and reasonable agreement is obtained with previous experimental work. The effects of a gas gap on the rewetting of a UO_2-filled Zircaloy tube are discussed. A simple physical model is also presented which shows the dominant parameter in determining the effect of a filler. It is suggested that previous theories for rewetting rate derived for empty tubes can be modified to include the effects of a filler by the use of a conduction correction term.

631 State of LWR technology in the Federal Republic of Germany. Gruener, W.; Kumpf, H. (Kraftwerk Union A.G., Erlangen (Germany, F.R.)). **22**: No. 4, 180-185(Apr 1977). (In German).

7 figs.

It was only eight years after the start-up of the first 237 MW demonstration plant that Biblis A, the world's largest nuclear power station at its time (1,300 MW), started operation. During this short interval, the German reactor industry had reached an internationally recognized standard of technology and safety. This was only possible by following a well-tried conception with the targets of standardization and limitation to a small number of characteristic parameters.

632 Present status and future prospect of light water reactors. Imai, R.; Kuge, Y. (Japan Atomic Power Co., Tokyo). pp 304-337 of In Genshiryoku hatsuden kaihatsu suishinjo no shomondai. Tokyo, Japan; Fuji International (1976). (In Japanese)

Light water reactors have developed because of the military use by US Navy such as the power sources for submarines. At present, most power reactors in the world are light water reactors. The construction of light water power reactor plants is in progress. Problems arise owing to the increasing number of power reactor plants. The supply of the reactor fuel will be limited by the capacity of uranium enrichment facilities. The production of uranium will not increase very much. Number of engineers and technicians is not sufficient for the large number of reactor plants. The reprocessing of spent fuel involves serious problems, and they must be considered. Safety in designing, quality control, and maintenance should be paid due attention. The standardization of reactor design is under consideration by US makers. Environmental problems, such as waste disposal and radiation protection, become now social problems. The effective use of uranium is required in view of energy utilization.

633 Actual condition of and counterplan to corrosion cracking of materials for pressure boundary of primary system of reactors. Kondo, T. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). pp 160-169 of In Genshiryoku hatsuden kaihatsu suishinjo no shomondai. Tokyo, Japan; Fuji International (1976). (In Japanese)

The actual condition of and the counterplan to the stress corrosion cracking of reactor materials are investigated. The main cause of the failure of stainless steel pipes is the stress corrosion cracking (SCC). The positions where SCC occurs in boiling water reactors (BWR) are mostly the bypass tubes of recycle loops and the emergency core spray system. Heat treatment may produce some effect in the material. Since SCC is not seen in pressurized water reactors (PWR), it is considered that the condition of water may have effects on the SCC. The relation between SCC and the residual stress after welding was studied, and it is suspected that the residual stress is one of the causes of SCC. Oxygen dissolved in water have a serious effect on stainless steel. The cracking in high temperature water is grain boundary cracking. The counterplan to SCC is considered from the viewpoints of the sensitivity of material, surrounding corrosive condition, and stress level. The carbide-stabilized steel is the strongest material against SCC, but it is hard to weld. Other steel with low resistance to general corrosion can be considered. The propagation of SCC and the mode of cracking are also studied.

634 Sensitivity of nuclear fuel cycle costs to uncertainties in nuclear data and methods. Harris, D.R. Troy, NY; Rensselaer Polytechnic Inst. (1976). 239p. University Microfilms Order No. 77-13,707.

Thesis (Ph. D.).

A sensitivity analysis system is developed for assessing the economic implications of uncertainties in nuclear data and related computational methods for light water power reactors. Results of the sensitivity analysis indicate directions for worthwhile improvement in data and methods. Benefits from improvements in data and methods are related to reduction of margins that are provided by designers to ensure meeting reactor and fuel objectives. The sensitivity analysis system relates costs to uncertainties in nuclear data and methods by two sequences of operations broken at the few group data level. Path B determines the sensitivity of reactor fuel cycle cost to uncertainties in few group microscopic cross sections. Then for important cases Path A analysis relates few energy group cell-averaged microscopic cross sections to uncertainties in basic nuclear data and in related computational methods.

635 Etude du marche europeen des centrales nucleaires industrielles pour la production mixte de vapeur et d'electricite. (Study of the European market for industrial nuclear power plants for the mixed production of electricity and steam). Luxembourg; Communautes Europeennes (Aug 1975). 77p. (In French).

The opportunity of developing the mixed production of electricity and steam from nuclear power plants in the nine countries of the European Community is studied. Both public distribution and autonomous production are envisaged. An attempt is made to estimate the potentiel market for district heating and for chemical, agricultural and alimentary, textile, paper, car manufacture and wood industries. The reactors considered are LWR reactors of at least 1000MWth. Suggestions are given to overcome the difficulties and constraints that stand in the way of a nuclear solution.

636 Fuel assembly. Hosokawa, T.; Maki, H.; Shinpo, K.; Ando, S. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-106898/A/. 17 Mar 1975. 5p. (In Japanese).

Object: To provide a reactor fuel assembly having a burnable poison addition fuel rod, and particularly, to enhance a reliability of the burnable poison addition fuel rod. Structure: A reactor fuel assembly having a fuel rod in which burnable poison (inflammable neutron absorber) is added into a fissile material, said fuel assembly comprising a burnable poison addition fuel rod, wherein nominal wall thickness of a clad tube for the burnable poison addition fuel rod is greater than that of a clad tube for a fuel rod not containing burnable poison, and a fuel rod not containing the burnable poison.

637 Apparatus for exchanging fuels in a reactor. Kiguchi, T. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-102798/A/. 7 Mar 1975. 4p. (In Japanese).

Object: To exactly position a fuel exchanger by mounting an ultrasonic transmitter and an receiver therefor at the lower end of a fuel gripping means. Structure: Ultrasonic waves are transmitted against a support lattice for a fuel assembly, the reflected waves from an upper surface of the lattice frame are received by a detector to produce a signal, a truck is moved on rails according to the signal to lower a positioning support on a mesh, a fuel exchanger is then lowered through the same path and a fuel assembly is gripped and pulled out of the reactor core.

638 Inservice inspection of nuclear power plants. Lingafelter, J.W. pp 127-142 of In Nuclear safety, 1975. Hetrick, D.L. (ed.). Hinsdale, IL; American Nuclear Society (1975).

From ANS topical meeting on nuclear safety; Tucson, Arizona, USA (5 Oct 1975).

See CONF-751044—.

A discussion is presented of the rules, working conditions, methods, and effectiveness of the inservice inspection (ISI) of nuclear plants in 1975.

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, NON-BOILING WATER COOLED

REFER ALSO TO CITATION(S) 622, 624, 627, 628, 629, 630, 634, 638, 836, 838, 840, 842, 847, 848, 851, 854, 855, 863, 864, 865

639 (BAW—10046A(Rev.1)) **Methods of compliance with fracture toughness and operational requirements of 10 CFR 50, appendix G.** Palme, H.S.; Behnke, H.W.; Keyworth, W.J. Jul 1977. 84p. and Wilcox, Lynchburg, VA.

The report describes B and W's practices, methods, and criteria for compliance with the requirements of Appendix G to 10 CFR 50, "Fracture Toughness Requirements." The ferritic materials and the operational parameters of the reactor coolant system for nuclear power plants designed by B and W are described as are the methods for obtaining and estimating the reference temperature and the Charpy upper shelf energy. The design curves used to predict radiation effects and the acceptance criteria for unirradiated Charpy upper shelf are given. The adequacy of fracture toughness properties of bolting materials and type 403 materials are demonstrated. The methods employed to determine the reactor coolant system pressure-temperature limit curves are given for each of the loading conditions required by Appendix G to 10 CFR 50. The pressure-temperature limit curves imposed by several regions of the reactor vessel are illustrated as is the development of the composite limit curves. The Technical Specifications pressure-temperature limit curves and the Preservice System Hydrostatic Test limit curve of a typical Oconee-type plant are also described.

640 (WCAP—9106) **Axial power distribution monitoring using four-section ex-core detectors.** Easter, J.R. Jul 1977. vp. Electric Corp., Pittsburgh, PA.

A summary is presented of the work Westinghouse has performed over the last several years regarding the use of a four section, axially mounted ex-core detector system for providing continuous, on-line axial power distribution measurements. The derivation of the equations used to transform four detector signals into a detailed representation of the core average axial power distribution is included. An explanation of the calibration procedure, and the in-plant testing program for the system are described.

641 Experience in vibro-acoustic control of primary coolant circuit aggregates. Sedov, V.K.; Adamenkov, K.A. (Nuclear power plant Novo-Voronesh (USSR)). **20**: No. 10, 328-331(Oct 1977). (In German).

Translation of 'Desyatiletnij opyt ehksplutatsii Novovoroneshskoj AEhS', Novo-Voronesh 1974, p. 116-125.

Fundamental principles and possibilities of vibro-acoustic control of the primary coolant circuit in nuclear power plants for detecting failures (slack parts, penetration of foreign bodies, crack formation, etc.) are presented. As a result of pressure and flow rate fluctuations such failures give rise to characteristic changes in apmplitude and frequency of vibration and technological noise from the different aggregates with respect to a 'calibration' spectrum taken in the intact state. Nature and location of the failures may be determined by statistical analysis of the signals recorded from pressure and acceleration gauges. Certain parts of the primary circuit are controlled, especially the main circulation pumps. Additionally, neutron noise has been measured in order to control the core insertions. The method is illustrated by means of measurements performed in the units 1 to 4 of the Novovoronezh nuclear power plant during start-up operation and continuous operation.

642 Power density studies on small lattices of WWER-440 fuel assemblies. Experiment and calculation. Andrianov, G.Y.; Ionov, V.S.; Novikov, A.N.; Barbolin, K.V.; Klochkov, A.D.; Azova, V.M. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). **20**: No. 10, 309-316(Oct 1977). (In German).

Power density distribution in the fuel elements of critical lattices consisting of WWER-440 type fuel assemblies have been measured using the activation technique. Results of these measurements are compared with data obtained from calculations using the NI7000 code. Experiments and calculations are briefly described.

643 Choice of the method for transposition of fuel assemblies in refueling WWER-440 reactors. Kokhanovzkaya, L.V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). **20**: No. 10, 307-308(Oct 1977). (In German).

The pattern of WWER-440 reactor refueling was recalculated after the more precise definition of BIPR-code input constants. Some fundamental operating characteristics are given for the first seven years of reactor operation. The calculated pattern of refueling ensures sufficient smoothing of power density distribution over the core.

644 Some trends in improving core and fuel cycle in WWER type reactors. Ovchinnikov, F.Y.; Sedov, V.K.; Golubev, L.I.; Dobrynin, V.D.; Tsybenko, V.M. (Nuclear power plant Novo-Voronesh (USSR)). **20**: No. 10, 302-306(Oct 1977). (In German).

Translation of 'Desyatiletnij opyt ehksplutatsii Novovoroneshskoj AEhS', Novo-Voronesh 1974, p. 51-67.

A number of nuclear power plants has been commissioned in the USSR in the last years. During their operation investigations have been performed to raise economic parameters. In particular, neutron-physical and thermodynamic characteristics have been improved. The obtained new values have been introduced into the design of new nuclear power plants. Some essential problems of the studies performed at the Novovoronezh nuclear power plant are presented in detail and discussed considering particularly fuel economics.

645 Review of neutron operating data of WWER type reactors and their comparison with calculations. Semenov, V.N.; Koroloev, B.A.; Gubareva, L.B. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). **20**: No. 10, 319-325(Oct 1977). (In German).

Values of some integral and local neutron-physical characteristics - change of boron concentration in the coolant, change in built-in reactivity with time, duration of reactor campaign, relative power of the fuel assemblies, power density over the reactor core, critical positions of the control groups during xenon poisoning, power and temperature coefficients of reactivity and their ratio -measured in reactors of the Novovoronezh and Kola nuclear power plants during operation in power range are discussed and compared with those calculated on the basis of the BIPR code. The results show that for purposes of improved calculation of fuel assembly and determination of the transposition of fuel assemblies during refueling the accuracy in measuring water heat-up in the fuel assemblies has to be increased to better than 5%, axial power distribution has to be controlled during the whole reactor campaign, and the BIPR-type codes have to be improved.

646 Pressurized water-cooled reactor system. Dorner, H.; Harand, E.; Kleiter, W. (to Siemens Aktiengesellschaft). US Patent 4,038,134. 26 Jul 1977. Filed date 29 Dec 1975. 8p.

An improved pressurized water-cooled reactor system is described which includes a reactor core pressure vessel; coolant lines coupled to the pressure vessel; vertically arranged steam generators having the housings thereof coupled to the coolant lines; and coolant pumps associated with the steam generators and coupled to the coolant lines. Each of the pumps has a vertically arranged impeller portion driven by an electric motor for circulating coolant between the pressure vessel and tube sheet type heat exchangers in the steam generators, at least the impeller portion of each pump being disposed within a chamber associated with each steam generator which is communicative with the coolant lines. The vessel, the coolant lines and the steam generators including the impeller chamber are each individually encapsulated by rupture-proof safety housings (encasements) forming a protection system for the primary loop components.

647 Nuclear fuel element nut retainer cup. Walton, L.A. (to Babcock and Wilcock Co.). US Patent 4,036,692. 19 Jul 1977. Filed date 1 Aug 1975. 6p.

A typical embodiment has an end fitting for a nuclear reactor fuel element that is joined to the control rod guide tubes by means of a nut plate assembly. The nut plate assembly has an array of nuts, each engaging the respective threaded end of the control rod guide tubes. The nuts, moreover, are retained on the plate during handling and before fuel element assembly by means of hollow cylindrical locking cups that are brazed to the plate and loosely circumscribe the individual enclosed nuts. After the nuts are threaded onto the respective guide tube ends, the locking cups are partially deformed to prevent one or more of the nuts from working loose during reactor operation. The locking cups also prevent loose or broken end fitting parts from becoming entrained in the reactor coolant.

648 Use of materials information in the design of PWR fuels. Jordan, K.R. (Westinghouse Electric Corp., Pittsburgh). **26**: 208(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

649 Gemeinschaftskraftwerk Neckar: history, start-up, experience. 29: No. 3, 51-59(Mar 1977). (In German).

With figs. and tabs.

This power plant differs from most of the other German power plants in some points: It is a 2-turbine plant for traction and three-phase current; it is the first 3-loop plant (in constrast to Biblis with its 4 standard primary loops) in the Federal Republic; axial main coolant pumps of this size have been used in the GKN for the first time. Besides, it has a number of other interesting features. ENERGIE interviewed the technical director of the GKN, Dipl.-Ing. Siegfried Bernhardt, on construction and start-up: 'The licensing procedure was the most nerve-racking part.'

650 Nuclear power station Biblis A has stood the test. 29: No. 3, 60-62(Mar 1977). (In German).

5 figs.

With the year 1976, the 1300 MW reactor Biblis A, operated by RWE, has completed its first year of operation. In spites of outages of spectacular publicity, it has been an efficient year for the first nuclear power plant of this size. In an interview with the journal ENERGIE, the director of the Biblis nuclear power station talks about operational experience, changes, expectations, and improvements to be made.

651 Detection of cavitation phenomena in coolant pumps. Klockgether, J. (Technische Univ. Berlin (Germany, F.R.). Inst. fuer Kerntechnik). **22**: No. 6, 327-328(Jan 1977). (In German).

8 refs.

In current concepts of pressurized water reactors with the pumps lying on top, special precautions have to be taken to avoid cavitation, because of the greater geodetical suction lift. A method of measurement is developed permitting the detection of the onset of cavitation phenomena and also weak cavitation effects in coolant pumps.

652 Joint nuclear power plant Grohnde. Boettcher, D. (Preussische Elektrizitaets-A.G., Hannover (Germany, F.R.)). **27**: No. 1, 10-16(Jan 1977). (In German).

4 figs.

With regard to the Kernkraftwerk Grohnde, the author explains construction decision, site, licensing procedure, cost development, plant description, cooling system, and public relations.

653 Kernkraftwerk Stade - five years of successful operation. Cramer, H. **27**: No. 1, 20-24(Jan 1977). (In German).

6 figs.

Five years of successful nuclear power plant operation can be reported today. Some 23 milliards kWh electrical power were generated. This means for NWK and HEW a proportion of 25% and 15% resp. with regard to the electric power used in the service area. Thus, it was possible to have a stabilizing influence on electricity prices, in particular when in the autumn of 1973 the primary energy costs rose steeply. The average number of full-load operating hours during the first five years of operation amounts to 7,340 hours per year, which means that the expectations put in nuclear engineering have been fully met.

654 Komponenten des Primaerkreises von Leichtwasserreaktoren Werkstoffe. Entwurf. (Components of the primary circuit of LWR reactors. Materials. Draft). Koeln, Germany, F.R.; Heymanns (1977). 107p.

The present draft standard deals with production control, inspection, and quality control of materials used for reactor components.

655 Reactor containment for the Muelheim-Kaerlich power plant. Kalkoffen, F.; Lehmann, J. **59**: No. 6, 227-231(1977). (In German).

6 figs.

The construction of the 1,300 MW Muelheim-Kaerlich power plant began in January 1975. The authors present the reactor pressure vessel which consists of a gas-tight steel sphere of 56 m diameter and 30 mm wall thickness. This design ensures complete activity retention under all operation and accident conditions without affecting the environment.

656 Start-up testing of the biological shielding efficiency at NPP with WWER reactors. Iz''yurov, A.S.; Kuzhil', A.S.; Mironov, V.N.; Rymarenko, A.I.; Tsypin, S.G. **41**: No. 6, 395-399(Dec 1976). (In Russian).

For English translation see the journal Sov. At. Energy.

The experiments yielded detailed data on the main radiation source - the reactor. In addition, the gamma radiation fields of the WWER-440 reactor primary circuit were studied in great detail. Based on the experimental data obtained, a computer calculation technique is developed that may be used for calculating the primary biological shielding behind the barrier and profiled shields. The program is convenient for determining the shielding profile as to its volume minimization and construction cost reduction. Data on the neutron flux density in the vessel region were used for obtaining the solution to modify the vessel internals of the 1st Unit of the Novo-Voronezh nuclear power plant. The experiments allowed the induced radioactivity value and distribution in the reactor vessel walls to be verified. The data were used to design a safety container for the reactor vessel surveys. The savings for one survey of the reactor vessel amounted to 600.000 rubles.

657 Unit 3 of the nuclear power station Doel. Preat, M. (Societe de Traction et d'Electricite, Brussels (Belgium)). No. 163, 43-50(1976). (In French).

Design data and planning activities for the Doel-3 reactor are described in a brief survey. Project work, siting, buildings, nuclear boiler, primary coolant circuit, the planning of the construction of the plant as well as a description of the safety aspects give a comprehensive impression of the facility.

658 Improved water density feedback model for pressurized water reactors. Casadei, A.L. Troy, NY; Rensselaer Polytechnic Inst. (1976). 172p. University Microfilms Order No. 77-13,705.

Thesis (Ph. D.).

An improved water density feedback model has been developed for neutron diffusion calculations of PWR cores. This work addresses spectral effects on few-group cross sections due to water density changes, and water density predictions considering open channel and subcooled boiling effects. An homogenized spectral model was also derived using the unit assembly diffusion method for employment in a coarse mesh 3D diffusion computer program. The spectral and water density evaluation models described were incorporated in a 3D diffusion code, and neutronic calculations for a typical PWR were completed for both nominal and accident conditions. Comparison of neutronic calculations employing the open versus the closed channel model for accident conditions indicates that significant safety margin increases can be obtained if subcooled boiling and open channel effects are considered in accident calculations. This is attributed to effects on both core reactivity and power distribution, which result in increased margin to fuel degradation limits. For nominal operating conditions, negligible differences in core reactivity and power distribution exist since flow redistribution and subcooled voids are not significant at such conditions. The results serve to confirm the conservatism of currently employed closed channel feedback methods in accident analysis, and indicate that the model developed in this work can contribute to show increased safety margins for certain accidents.

659 Comparison of pressurized water reactor system model with test results and evaluation of nonlinear effects. Cooper, K.F.; Cain, J.T. pp 1055-1060 of In Modeling and simulation. Volume 7,

Part 2. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P2.

A proposed model of a Pressurized Water Reactor (PWR) Nuclear Power System was presented at the Sixth Modeling and Simulation Conference (Reference 1). The model presented consisted of the nuclear reactor as a heat source and a single lumped primary fluid system and steam generator. The model developed consists of nonlinear, constant coefficient, ordinary differential equations and has been programmed for solution using the TAF digital simulation code. The purpose in developing the PWR system model was to establish a system model which could be used for optimal control system studies. A comparison is presented of the developed nonlinear model with test data from an operating plant and with another system model which has been used for system design and analysis studies. In addition, a linearized version of the proposed model is presented and compared with the nonlinear version of the PWR model.

POWER REACTORS, NON-BREEDING, GRAPHITE MODERATED

REFER ALSO TO CITATION(S) 732, 733, 734, 735, 736, 840, 1149

660 (GA-A—14512) **Component and systems development program. Quarterly progress report for the period ending June 30, 1977.** Jul 1977. Contract EY-76-C-03-0167-050. 86p. Dep. NTIS, PC A05/MF A01.

Progress is summarized in the following areas: (1) component and structural materials, (2) thermal barrier studies, and (3) reactor internals studies. The objectives of these tasks are to provide a data base for the properties of materials used in the construction of important noncore components of the HTGR and to demonstrate the adequacy of the thermal barrier and reator internal design.

661 **HTGR fuel rods: carbon-carbon composites designed for high weight and low strength.** Bullock, R.E. (General Atomic Co., San Diego, Calif. (USA)). **12**: No. 8, 1499-1518(Aug 1977).

The evolution of the process for fabricating fuel rods for the high-temperature gas-cooled reactor (HTGR) by injection and carbonization of a thermoplastic matrix that bonds close-packed beds of pyrocarbon-coated fuel particles together is reviewed for the fresh-fuel cycle, and a variant process involving a thermosetting matrix that would allow free-standing carbonization of refabricated fuel is discussed. Previous attempts to fabricate such injection-bonded fuel rods from undiluted thermosetting binders filled with powdered graphite were unsuccessful, because of damage to coatings on fuel particles that resulted from strong particle-to-matrix bonding in conjunction with large matrix shrinkage on carbonization and subsequent irradiation. These problems have now been overcome through the use of a diluted thermosetting matrix with a low-char-yield additive (fugitive), which produces a more porous char similar to that from the pitch-based thermoplastic used in fabrication of fresh fuel. A 1-to-1 dilution of resin with fugitive produced the optimum binder for injection and carbonization, where the fired matrix in such rods contained about 20 wt% binder char and 80 wt% powdered graphite. Thermosetting fuel rods diluted with various amounts of fugitive to give binder chars that range from 12 to 48 wt% of the fired matrix have been subjected to irradiation screening tests, and rods with no more than 32 wt% binder char appear to perform about as well under irradiation as do pitch-based rods. However, particle damage does begin to occur in those lightly diluted rods in which the less-stable binder char constitutes more than 32 wt% of the fired matrix.

662 **Nuclear reactors.** Rickard, A.R.; George, B.V. (to Nuclear Power Company Ltd.). US Patent 4,036,687. 19 Jul 1977. Priority date 10 May 1974, United Kingdom of Great Britain and Northern Ireland (UK). 6p.

In a nuclear reactor installation comprising a fluid-cooled nuclear heat source within a primary pressure vessel, the latter is enclosed within a secondary containment means which comprises a lower wall portion surrounding the primary pressure vessel, an annular portion extending out from the lower wall portion, and an upper portion integral with the annular portion and extending over it and over the primary pressure vessel and housing handling means for lifting fuel and other reactor components through normally sealed vertical penetrations in the roof of the primary pressure vessel (giving access to the reactor core) and in the annular portion (giving access to new and spent fuel stores and other auxiliary facilities disposed outside the secondary containment and wholly or partly below the annular portion).

663 **Benefiting from experience with gas-cooled reactors.** Masters, R. **22**: No. 259, 29-30(Jul 1977).

The work of the Berkeley Nuclear Laboratories in improving the performance of Magnox reactors is being extended to AGRs. Studies briefly considered include those for improving the life of fuel elements. Some views in support of the AGR, expressed at a meeting of the Institution of Mechanical Engineers are recounted. With the favourable performance of the first four AGRs Britain could for the first time build a nuclear power station based on proven commercial design.

664 **Material criteria and selection for VHTR heat exchangers.** Quade, R.N.; Trester, P.W. (General Atomic Co., San Diego, CA). **26**: 199-200(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

665 **Materials for primary circuit components in advanced gas-cooled reactor systems.** Kimball, O.F. (General Electric Co., Schenectady, NY); Frank, R.G.; Fox, J.E. **26**: 200-201(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

666 **Thermal insulation for tanks.** von Waclawiczek, H. (to Gesellschaft fuer Hochtemperaturreaktor-Technik m.b.H., Bergisch Gladbach (Germany, F.R.)). German(FRG) Patent 2,532,895/A/. 10 Feb 1977. 8p. (In German).

1 fig.

The proposal is concerned with a thermal insulation for tanks and pipes, especially an internal insulation for the pressure vessel of a gas-cooled high-temperature nuclear reactor protecting against very high temperatures and being cheap at the same time. It is proposed to build up a number of closed cells, in fine honeycomb structure in the way of brickwork of known high-temperature resistant cermic bodies taking over the heat protection. A construction in several layers is to be constituted in such a way that the expansion joints of neighboring layers will overlap; if necessary, insulating fiber mats may be added.

667 **Method of isolating spheres of about equal kind and size from irregular heaps and device for achieving it.** Rachor, L. (to Hochtemperatur-Reaktor-Brennelement G.m.b.H. (HOBEG), Hanau (Germany, F.R.)). German(FRG) Patent 2,525,259/A/. 9 Dec 1976. 6p. (In German).

2 figs.

In order to single out spheres of about equal kind and size - especially spherical fuel elements for nuclear reactors-, it is proposed to let gravity act upon them, thus safely avoiding damaging the surface. According to the invention, they are fed into a V-shaped discharge channel (generating angle between 55° and 67°, inclination 2° to 10°) being at least 25 times longer than the diameter of the spheres. In this way, a linear arrangement is obtained effortless from an irregular heap.

668 **Method and device for isolating small spheroids from irregular heaps of such spheroids.** Rachor, L.; Hauer, M. (to Hochtemperatur-Reaktor-Brennelement G.m.b.H. (HOBEG), Hanau (Germany, F.R.)). German(FRG) Patent 2,525,258/A/. 9 Dec 1976. 8p. (In German).

4 figs.

A method is described for isolating spherical particles especially fuel particles for nuclear reactors, where these will suffer as little damage as possible. This is achieved by supplying them to a rotating disc provided with a perforated face through which the spheres are sucked in. A gas flow directed to the perforated disc provides for uniform destibution. Details of the apparatus are described.

669 **Device for sorting out spheres with damaged surface and varied diameter of a pebble bed.** Huendorf-Richter, B.; Decken, K.B. v.d.; Faber, H.R. (to Hochtemperatur-Reaktorbau G.m.b.H., Koeln (Germany, F.R.)). German(FRG) Patent 1,473,778/C/. 25 Nov 1976. 3p. (In German).

2 figs.

An improved device for sorting out spheres with damaged surface or varied diameter of a pebble bed (of a nuclear reactor) is described which has the advantage of guaranteeing high operational safety at a long testing path and a short total length. The spheres pass through a bent sphere discharge tube on to a rotating plate, are removed from it through a boring, and enter into a worm part formed by several threads rigidly connected with the plate. Here, the surfaces are scanned at all positions, and damaged particles are discharged. Details of the apparatus are described.

670 **Method for placing a manipulator into the prestressed-concrete vessel of a nuclear reactor.** Hendrich, K.; Mahalbasic, M. (to Hochtemperatur-Reaktorbau G.m.b.H., Koeln (Germany, F.R.)). German(FRG) Patent 2,509,025/A/. 2 Sep 1976. 19p. (In German).

6 figs.

A method is given in which a manipulator is to be placed in pre-stressed concrete pressure vessels of a gas-cooled nuclear reactor. The manipulator consists of a stand pipe and several telescope arms supported by the stand pipe arranged at right angles to it and movable. It is for the inspection of the pressure vessel and for possibly necessary repairs. A suggestion is made to drive in and support the stand pipe (after dismounting of all the fuel elements) through the central loading epening, to introduce the telescope arms each individually through one of the vertical pods transported by means of a swivelling transport system through the horizontal gas pipelines and joint to the stand pipe. A number of additional auxiliary means to extend the operating possibilities of the manipulator are described. Five diagrams illustrate the invention.

671 Survey of thorium utilization in power reactor systems. Schwartz, M.H. (General Atomic International, San Diego, CA); Schleifer, P.; Dahlberg, R.C. pp 223-244 of In Nuclear power development and the fuel cycle. Farmakes, R. (ed.). Hinsdale, IL; American Nuclear Society, Inc. (1976).

From 1. Pacific Basin topical conference on nuclear development and the fuel cycle; Honolulu, Hawaii, United States of America (USA) (11 Oct 1976).

See CONF-761014—.

It is clear that thorium-fueled thermal power reactor systems based on current technology can play a vital role in serving present and long-term energy needs. Advanced thorium converters and thermal breeders can provide an expanded resource base from which the world's growing energy demands can be met. Utilization of a symbiotic system of fast breeders and thorium-fueled thermal reactors can be particularly effective in providing low cost power while conserving uranium resources. Breeder reactors are characterized by high capital costs and very low fuel costs since they produce more fuel than they consume. This excess fuel can be used to fuel thermal converter reactors whose capital costs are low. This symbiosis is optimized when ^{233}U is bred in the fast breeders and then used to fuel high-conversion-ratio thermal converter reactors operating on the thorium-uranium fuel cycle. The thorium-cycle HTGR, after undergoing more than fifteen years of development in both the United States and Europe, provides for the optimum utilization of our limited uranium resources. Other thermal reactor systems, previously operating on the uranium cycle, also show potential in their capability to utilize the thorium cycle effectively.

672 Development of a mathematical simulation of the HTGR core auxiliary cooling system. Leech, W.D.; Spurgin, A.J.; Person, R.D. pp 1049-1054 of In Modeling and simulation. Volume 7, Part 2. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P2.

The development of a mathematical simulation of the dynamic behavior of the core auxiliary cooling system (CACS) for the HTGR is presented. The equations that were developed for the auxiliary circulator, auxiliary heat exchanger, HTGR core, and CACS control system are presented. Design modifications to the control system as a result of simulation are also presented.

POWER REACTORS, NON-BREEDING, OTHERWISE MODERATED OR UNMODERATED

673 Nuclear fuel element. Meadowcroft, R.R.; Bain, A.S. (to Atomic Energy of Canada Ltd.). US Patent 4,036,691. 19 Jul 1977. Priority date 3 Dec 1975, Canada. 4p.

A nuclear fuel element is described which has a tubular cladding of zirconium or a zirconium alloy and a fission gas plenum chamber which is held against collapse by the loops of a spacer in the form of a tube which has been deformed inwardly at three equally spaced, circumferential positions to provide three loops. A heat resistant disc of graphite separates nuclear fuel pellets within the cladding from the plenum chamber. The spacer is of zirconium or a zirconium alloy.

674 Influence of heavy water moderated reactors on uranium use. Mostert, P. (Keuring van Elektrotechnische Materialen N.V., Arnhem (Netherlands). Reactor Development Group). 1: No. 6, 187-191(Jun 1977). (In Dutch).

From Symposium concerning heavy water moderated reactors; Utrecht, Netherlands (9 Apr 1976).

5 refs., 6 figs., 3 tables.

A cost-benefit analysis of heavy water moderated reactors as opposed to water moderated reactors is presented. The analysis is performed in terms of neutron economy, the yield of fissionable material, and the possibilities of fast breeder reactors.

675 Convergence of materials and design criteria in advanced reactors. Boulton, J. (Whiteshell Nuclear Research Establishment, Pinawa, Manitoba). 26: 208-209(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

POWER REACTORS, BREEDING

REFER ALSO TO CITATION(S) 840, 845, 849, 850, 868, 1112

676 (CONF-770401—30) Application of an advanced shielding analysis system to gas-cooled fast reactor designs. Bartine, D.E.; Williams, L.R. 1977. Contract W-7405-ENG-26. 10p. Dep. NTIS, PC A02/MF A01.

From 5. international conference on reactor shielding; Knoxville, Tennessee, United States of America (USA) (18 Apr 1977).

In its shielding program for General Atomic's Gas-Cooled Fast Reactor (GCFR), Oak Ridge National Laboratory has developed an advanced shielding analysis system that incorporates the latest analysis techniques for converging to a shield design compatible with other design parameters. Basically the system consists in applying the various techniques in a logical sequence to a given design, thereby generating a large body of data to serve as an information base for subsequent redesigns by General Atomic. The first step is a discrete ordinates radiation transport calculation for a two-dimensional model of the reactor system. The resulting neutron and gamma-ray fluxes are then converted to isoplots of the responses of concern, and these are used to locate regions in the system at which those responses are higher than allowed by predetermined constraints. Next, adjoint calculations are performed for the regions of concern, and the resulting adjoint fluxes, together with the forward fluxes, are used in channel-theory calculations to determine the physical paths followed by the particles traveling from the core to those regions. In addition, the adjoint and forward fluxes are used in sensitivity calculations to determine the importance of the cross sections used in the transport calculations as functions of the shield materials and particles energies. Finally, the sensitivity results are utilized in the form of linear perturbation theory to predict the effect of changes in the shield composition and position on the various responses. This system is being applied to successive reference models for the GCFR and on the basis of the data obtained thus far the thickness of the radial shield has been significantly reduced and the lower shield region has undergone extensive redesign.

677 (CONF-770807—27) Some trends in constitutive equation model development for high-temperature behavior of fast-reactor structural alloys. Pugh, C.E.; Robinson, D.N. 1977. Contract W-7405-ENG-26. 25p. Dep. NTIS, PC A02/MF A01.

From 4. international conference on structural mechanics in reactor technology; San Francisco, California, United States of America (USA) (15 Aug 1977).

The paper addresses some important features of the inelastic behavior of $2\frac{1}{4}$Cr—1Mo steel and indicates a mathematical framework that is capable of representing these types of response. While the constitutive model discussed embraces capabilities beyond those of equations presently used in design analyses; their implementation into practicable analysis methods (such as finite-element programs) is more demanding. For example, in the case of slow time-dependent deformations, the equations governing accumulation of the inelastic strain components and the evolution of the tensorial state variable α are intimately coupled. A part of recommending any such model for use in design must be a quantitative assessment of the economic feasibility of implementation.

678 (GA-A—14358) Gas-Cooled Fast Breeder Reactor. Quarterly progress report, February 1, 1977—April 30, 1977. May 1977. Contract EY-76-C-03-0167-023. 268p. Dep. NTIS, PC A12/MF A01.

Progress is summarized in the areas of development of GCFR fuel, blanket, and control assemblies; development of the pressure equalization system for GCFR fuel; out-of-pile loop facility test programs; fuels and materials development; fuel, blanket, and control rod analyses and development; nuclear analysis and reactor physics for GCFR core design; shielding requirements for the GCFR; reactor engineering to assess the thermal, hydraulic, and structural performance of the core and the core support structure; plant systems control; systems engineering; development of reactor components, including reactor vessel, control and locking mechanisms, fuel handling equipment, core support structure, shielding assemblies, main helium circulator, steam generator, and auxiliary circulator; development of a helium circulator test facility; reactor safety, environment, and risk analyses, including planning and support of an in-pile and out-of-pile safety test program; nuclear island engineering design; and development of a reliability data bank.

679 (WAPD-TM—1231) **Thorium oxide granule and compact properties which are important to ThO_2 and ThO_2—UO_2 fuel pellet fabrication (LWBR development program).** Busby, C.C.; Clayton, J.C. Jan 1976. Contract EY-76-C-11-0014. 113p. Dep. NTIS, PC A06/MF A01.

The source ThO_2 powder properties were related to the conditions for granulation, cold compaction and decarburizing pretreatment of green thoria pellets. Granulation with a liquid/solids agglomeration process was found to occur by snowballing thoria powder around an initial droplet of dissolved organic binder resulting in the highest binder content being concentrated in the center of the granule--the higher the binder content, the larger the binder core region. An increase in binder content or heat treatment of the thoria granule above the binder melting point significantly increased the granule crush strength primarily by densification of the granules. The ratio of granule bulk density to geometric density was around 0.6, a value consistent with random close-packing and the primarily spherical shape of the granules.

680 (WARD-XS—3045-18) **Physics evaluations and applications .** Arakali, V.; Davis, W.J.; Paik, N.C. May 1977. Contract EY-76-C-02-3045. 15p. .

Progress is summarized in the following areas: implementation of the VENTURE code on the Westinghouse NES CDC-7600 computer, Doppler effects on power transients initiated by a step reactivity insertion in a typical LMFBR, and analysis of blanket composition to minimize blanket power variation. (DG)

681 **30 MW(th) steam generator of the BOR 60 fast reactor.** Krizek, V.; Dubsek, F. (Prvni Brnenska Strojirna (Czechoslovakia). Vyzkumny Ustav Energetickych Zarizeni). **20**: No. 9, 283-286(Sep 1977). (In German).

From 7. Meeting on power plant engineering; Dresden, German Democratic Republic (30 Sep 1975).

Extraordinary efforts are made towards research and development of steam generators for nuclear plants with sodium-cooled fast reactors throughout the world. From the viewpoint of safe operation the Czechoslovak solution of the micromodule steam generator seems to be very advantageous. The weldless heat transfer tubes are mounted in a double tube plate equipped with a leak indicator between the walls. In case of a possible water leakage into the sodium, the chemical reaction and its accident chain cannot propagate like an avalanche to the tubes of other modules. No difficulties and troubles have occurred during operation of the module steam generator at the BOR 60 reactor since July 26, 1973. The results obtained are a presupposition of successfully managing the future, yet uncompleted units of this type intended for large nuclear power plants with fast reactors. They are a result of the bilateral Soviet-Czechoslovak co-operation in the field of nuclear power.

682 **Nuclear reactor with suspended fuel assemblies having secondary emergency suspensions.** Bittermann, D.; Hunt, K.; Klein, K.; Rau, P. (to Siemens Aktiengesellschaft). US Patent 4,038,133. 26 Jul 1977. Priority date 19 Apr 1973, German, Federal Republic of (F.R. Germany). 8p.

A reactor has a core formed by a plurality of laterally adjacent fuel assemblies, each assembly comprising a vertically elongated casing containing a bundle of fuel rods and having an upper end connected to a tubular suspension rod forming the primary suspension means for the casing, failure of this means permitting the fuel assembly to drop from the core. In each instance, an instrumentation tube having an upper end supported independently of the primary suspension rod, extends downwardly through the latter, and centrally through the casing to the lower end of the latter. This instrumentation tube and the fuel assemblies adjacent to each other remain suspended so as to form vertically fixed parts relative to any one assembly that might drop accidentally. Each of the casings have latch means for normally latching the casing to one of these fixed parts so as to each casing it cannot fall substantially relative to that one of the parts in the event of a failure of its tubular suspension rod normally forming its primary suspension.

683 **Support structure for the lateral neutron shield system of a fast reactor core.** Gallet, B.; Venot, R. (to Commissariat a l'Energie Atomique). US Patent 4,038,136. 26 Jul 1977. Priority date 11 Jun 1974, France. 4p.

A hexagonal ring structure whose internal contour conforms to the external contour of the reactor core rests on the periphery of the reactor diagrid and is constituted by a plurality of layers of metallic plates. The layers are maintained in relative positional relation by means of clamping members, the plates of one layer being angularly displaced with respect to the plates of adjacent layers. The bottom end-connectors of the elements constituting the lateral shield system are fitted in vertical through-holes formed in the ring structure.

684 **Nuclear reactor fuel element assemblies.** Betts, C.; Collinson, A.E.; Hart, D.F. (to United Kingdom Atomic Energy Authority). US Patent 4,036,690. 19 Jul 1977. Priority date 31 Dec 1974, United Kingdom of Great Britain and Northern Ireland (UK). 4p.

A nuclear reactor fuel element assembly comprising a bundle of fuel elements in a tubular wrapper for conducting liquid metal coolant flow has a cavitation suppressing impedance. The impedance comprises a tubular member housing a series of flow defining plates, the plates comprising two sets arranged so that plates of each set are positioned alternately along the tubular member, the plates of one set being of woven wire mesh and those of the other set being thick apertured plates.

685 **Advanced systems and applications. 1**: No. 7, . 240-242(Jul 1977). (In Dutch).

A short survey is presented by the observer from the Netherlands' Energy Research Centre to the 1977 Salzburg Conference dealing with the Session on advanced systems and their applications, such as thermal breeder reactors, fast breeder reactors, use of reactor heat for industrial processes, a fusion reactor combined with an MHD generator and nuclear ships.

686 **Role of simulation in the U.S. LMFBR Program.** Laidler, J.J. (Westinghouse Hanford, Richland, WA). **26**: 186-187(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

687 **Effect of swelling and creep on LMFBR performance.** Baarthold, W.P. (Argonne National Lab., IL). **26**: 206(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

688 **Materials properties utilization in a cumulative mechanical damage function for LMFBR fuel pin failure analysis.** Jacobs, D.C. (Westinghouse Advanced Reactors Div., Madison, PA). **26**: 209(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

689 **Stress-free swelling in Type 316 stainless steel at high fluences.** Kenfield, T.A.; Appleby, W.K.; Busboom, H.J. (General Electric Co., Sunnyvale, CA). **26**: 210(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

690 **Effect of heat treatment on tensile properties of annealed 2 1/4 Cr-1 Mo steel.** Kleuh, R.L. (Oak Ridge National Lab., TN). **26**: 211-212(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

691 **Reaction rate of sodium with ethanol and other alcohols.** Welch, F.H.; Steele, O.P. III. (Atomics International, Canoga Park, CA). **26**: 214(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

692 **Simplified thermal transient and inelastic analysis screening methods per appendix T, Code Case 1592 for 2 1/4 Cr-1 Mo steel.** Veljovich, W.; Skopp, G.; Anderson, T.L. (Atomics International, Canoga Park, CA). **26**: 214-215(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

693 **Cracked hexagonal ducts.** Petroski, H.J. (Argonne National Lab., IL). **26**: 215(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

694 **Tritium permeation through steam generator materials.** Renner, T.A.; Raue, D.; McPheeters, C.C. (Argonne National Lab., IL). **26**: 216(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

695 **Enrichment and control optimization in LMFBRs losing reactivity during burnup.** Tzanos, C.P. (Argonne National Lab., IL). **26**: 232-233(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

696 Transitory fuel growth rates for fast breeder reactors. Maudlin, P.J.; Borg, R.C.; Ott, K.O. (Purdue Univ., West Lafayette, IN). **26**: 235-236(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

697 Directional integration method for two-dimensional fluid transients. Shin, Y.W. (Argonne National Lab., IL). **26**: 241-242(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

698 Fast breeder reactor and method for its operation. Gratton, C.P. (to UKAEA London Office). German(FRG) Patent 1,764,112/B/. 10 Mar 1977. 2p. (In German).

5 figs.

The invention refers to a method of operating a fast breeder reactor whose core consists of a fission zone and breeding blankets. It is aimed for the utilization of fissile and fertile material to be as high as possible. For this purpose, at the end of each operational period, a method of charging and discharging dealt with by the invention and described further is proposed. The fuel elements contain fertile material in the end regions and fissile material in the middle regions.

699 Shock absorber for liquid metal plants. Dumm, K. (to Internationale Atomreaktorbau G.m.b.H. (INTERATOM), Bergisch Gladbach (Germany, F.R.)). German(FRG) Patent 2,533,231/A/. 10 Feb 1977. 11p. (In German).

3 figs.

Shock-wave absorber protecting the heat-exchangers and their pipings in liquid-metal cooled nuclear rower plants against dynamic shock waves which may arise in cases of accident. The absorber is characterized by a container filled with gas and joined to the plant, which is closed by a rupture disc responding to dynamic pressure variations, and it has a throttling device becoming effective when part of the volume is filled with liquid metal in order that reflected waves will be absorbed, too. Variations of the special design of the throttling device are described.

700 Elongated fuel rod. Williams, A.E.; Linkison, W.S. (to UKAEA London Office). German(FRG) Patent 1,764,150/B/. 10 Feb 1977. 7p. (In German).

3 figs.

A fuel rod is proposed where a reorientation of the fuel in case of a considerable temperature increase, causing the melting of the densified fuel powder, will be avoided. For this purpose, in longitudinal direction of the fuel rod, a number of diameter reductions of the can are applied of certain distances. In the reduction zone the cross-sectional area of the fuel is reduced, as compared to the one of the remaining fuel material in the regions without diameter reduction, but not the density of the fuel. The recess is chosen to that in case of melting of the fuel in the center of the not contracted zone the fuel in the center of the narrowed area will remain solid and keep the molten material in position.

701 Incipient boiling of sodium in an annular channel heated by a single-pin with blockage. Fujiie, Y.; Okada, T.; Miyazaki, K.; Inoue, S.; Suite, T. (Osaka Univ., Suita (Japan); Faculty of Engineering). **13**: No. 10, 596-608(Oct 1976).

In simulation of partial failure affecting a fast breeder core, experiments on sodium boiling were performed in a single vertical channel of annular cross section (15mm I.D.), indirectly heated by high flux heater pin (6.5mm O.D., 60 cm heating length) and provided with a blockage disk (11 mm O.D., 1 mm thick, obstructing 42% of the channel area). The experimental conditions were; Pressure of cover gas: 1.0 kg/cm^2 abs., Heat flux: 0 -- 80 W/cm^2, Flow rate of sodium: 1 -- 4 l/min. The results revealed that the degree of incipient boiling superheat is reduced to a fraction of the value obtained previously for direct joule heating under similar conditions, and that, consequently, the intensity of pressure pulses is correspondingly reduced. On the other hand, the incipient boiling superheat increases, together with the extent of its scattering, with rising intensity of the heat flux. Local boiling was observed to precede the onset of bulk boiling, causing small pressure spikes to be detected by all three pressure sensors installed along the test channel. The pressures evaluated from the measured velocities of the liquid sodium column based on single-bubble model were compared with the measured pressure signals, and a fairly good agreement was obtained.

702 Fuel container for a nuclear reactor. Lunt, A.R. (to UKAEA London Office). German(FRG) Patent 2,608,537/A/. 16 Sep 1976. 11p. (In German).

3 figs.

An improvement is proposed on the fuel container of a liquid metal-cooled nuclear reactor (fast breeder) by which vibrations caused by the coolant flow may be damped. According to the invention, each fuel container carries at its upper end piece an inertia-based damping device, the liquid metal acting as a damping medium.

703 Fast breeder reactor. Ziegler, A. (to Siemens A.G., Berlin (Germany, F.R.); Siemens A.G., Muenchen (Germany, F.R.)). German(FRG) Patent 1,948,901/B/. 16 Sep 1976. 8p. (In German).

4 figs.

The invention deals with a fast breeder reactor with liquid metal cooling and with a fuel zone co-axially surrounded by a breeder zone without a separating wall, where the coolant is admitted to the whole cross-section of the breeder reactor with the same pressure. It is difficult in such nuclear reactors to maintain a constant pressure uniformly over the entire reactor cross-section. According to the invention, this is achieved in that one arrages the fuel elements as well as the breeder elements in open construction and designs flow-conducting devices arraged on top of one another which influence the coolant flow. The design of this flow-conducting device is part of the patent claims.

704 Results of research and development in analysing 75 MWt core characteristics of 'JOYO'. Inoue, T.; Yoshino, F.; Kaneko, H.; Tomabechi, K. (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). **18**: No. 9, 554-565(Sep 1976). (In Japanese).

Results of research and development performed for analyzing the core neutronic and thermal characteristics of Japanese experimental fast reactor JOYO are presented. The analysis and production of neutronic characteristics were performed based on the full mock-up experiments with FCA (Fast Critical Assembly) at JAERI and on two-dimensional diffusion calculation with 25-group constants (NNS-5). The outline of FCA experiments and C/E values for various characteristics values are presented. For thermal characteristics, the design criteria and the results of various experiments such as core hydraulic tests, assembly hydraulic tests, effects of coolant mixing, measurement of surface thermal conductivity, evaluation of instrument reliability and fabrication error, and the determination of hot spot factors are explained. The design values with allowance are also presented. As for fuel characteristics, the outline of the fuel assembly, the design specification, analysis of burnup characteristics, results of creep experiments, and the results of fuel in a diation experiments are summarized. The determination of final thermal output, which was 75 MW, is also elucidated together with the projected operational and refueling pattern. Design values for major items are also listed for both 50MW and 75MW cores.

705 Nuclear reactor for fast neutrons. Grischanin, E.I.; Murogow, W.M.; Orlow, W.W.; Kaluschskaia; Totschenii, L.W. German(FRG) Patent 2,141,008/B/. 19 Aug 1976. 3p. (In German).

4 figs.; 1 tab.

An improvement of nuclear reactors for fast neutrons is to make heat development in the fission zone more uniform. In nuclear reactors having a breeding blanket which surrounds a fission zone made up of an inner and outer zone part, where the zone parts are co-axially arranged, Pu-239 is used as nuclear fuel in the outer fission zone part and U-235 in the inner fission zone part. The ratio Pu-239 to U-235 is 0.5 to 5. The volume of the inner fission zone part is about 20 to 90% of the total volume of the fission zone.

706 Heat exchanger. Archer, D.H. (to Westinghouse Electric Corp., Pittsburgh, Pa. (USA)). German(FRG) Patent 2,546,543/A/. 6 May 1976. 13p. (In German).

6 figs.

A heat exchanger is proposed for the application in liquid-metal cooled fast breeder nuclear reactors, in which one may do without a liquid-metal intermediate loop. According to the invention, both tube bundles of the heat exchanger are surrounded by particles housing a particle size of 50 μm to 1,000 μm. A fluidized bed is produced by a fluidizing gas (e.g. helium), a cyclone separator retains the particles in the waste gas. The tube bundles are kept advantageously in separated sections.

707 Fuel rod for liquid metal cooled nuclear reactors. Vinz, P. (to Messerschmitt-Boelkow-Blohm G.m.b.H., Muenchen (Germany, F.R.)). German(FRG) Patent 2,449,597/A/. 22 Apr 1976. 8p. (In German).

2 figs.

The purpose of the invention is to design a nonwetting fuel rod for liquid metal cooled nuclear reactors so that its heat flux is considerably increased and the formation of a hot spot will be avoided. To achieve this, the fuel can, along the whole of its thermally active length, is enclosed by a wire coil wetted by the coolant (sodium). The coil consists of a reactor-compatible stainless steel wire of 0.05-0.5 mm diameter; it is mounted under initial stress and joined to the can by diffusion welding or soldering.

708 Reliability and safety methodology for an analysis of the Clinch River Breeder Reactor Plant. Fussell, J.B.; Wagner, D.P.; Cate, C.L. (Univ. of Tennessee, Knoxville). pp 1066-1070 of In

Modeling and simulation. Volume 7, Part 2. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P2.

The Clinch River Breeder Reactor Plant is a prototype sodium cooled fast breeder reactor plant being built along the Clinch River near Knoxville, Tennessee. The methodology is presented that will be used in the first stages of an independent risk assessment project concerning the Clinch River Breeder Reactor Plant that is being carried out at The University of Tennessee.

709 Construction materials swelling under neutron irradiation and its relation with the structural factor. Review. Romaneev, V.V. No. 10, 18-27(Oct 1975). (In Russian).

38 refs., 4 tables, 4 figs.

Swelling of construction materials when irradiated by neutrons in fast reactors is considered in detail. Considerable attention is given to stainless steels as the basic materials of active zones of fast reactors. Swelling data indicate that the stability of a structure of cold-deformed steel is an important factor which allows control of the swelling. Swelling of stainless steel subjected to thermo-mechanical processing seems to depend not only on the processing regime (degree of cold deformation, temperature, and length of annealing) but also on a combination of other factors: chemical state of the steel; quantity, size, and type of separated-out secondary phases; and stability of dislocation structures. Analysis of data indicates a relation between swelling of stainless steels and the microstructural factor and suggests a way to decrease swelling, i.e., treatment of stainless steels and alloys with 18-20% Cr and 35% Ni with introduction into these alloys of additional Al, Ti, and Nb; use of 15-20% cold deformation or of definite thermo-mechanical processing regimes for fuel element sheaths of 316 and FV548 steels; radiation alloying of stainless steels (introduction of Ti, Mo, Nb) and limiting the C, Si, Mn, and P contents.

POWER REACTORS, AUXILIARY, MOBILE, PACKAGE, AND TRANSPORTABLE

710 N_2O_4 as a working substance for a spacecraft power plant. Popyrin, L.S.; Starostenko, N.N.; Starostenko, V.I. No. 4, 53-57(1975). (In Russian).

A gas turbine cycle on dissociating nitrogen tetroxide (N_2O_4) as working medium is considered. Nitrogen tetroxide has a number of properties advantageous in this respect. A direct cycle power plant is considered. A fast reactor with a gas coolant is an energy source. Some versions of a power plant have been analysed for the gas temperature at the turbine inlet ranging from 1170 to 1470 K. The cycle efficiency is found to increase considerably with the working medium temperature rise at the turbine inlet only to 1380-1400 K. To determine the efficiency of the plants of this type, they are compared to identical designs of gas and gas-liquid cycles on alkali metals, inert gases, and dissociating phosphorus. Theoretical and experimental data show that the turbine with nitrogen tetroxide as working medium is more compact in comparison to that with inert gases. Small specific surfaces of the radiator, small size of the turbine and thermal process equipment, and high efficiency are evidence of the advisability of using the plant of the type considered as on-board power plant of a space ship.

REGULATION AND LICENSING

REFER ALSO TO CITATION(S) 1008

711 (NUREG—0197) **Improving regulatory effectiveness in federal/state siting actions: state regulatory activity involved in need for power.** Nassikas, J. Apr 1977. 54p. NTIS $4.50.

The individual views are presented of the panel members relating to the basic issues and framework for improvements of the Federal/state process for licensing of nuclear power plants, associated facilities, transmission lines, reprocessing of fuel and uranium enrichment. The synopsis supplements the initial synopsis of the views presented to the National Governors Conference Workshop "State Perspectives on Energy Facility Siting" in Atlanta, Georgia on December 15—16, 1976. Both synopses constitute the report of this panel.

712 (NUREG—0202) **Improving regulatory effectiveness in federal/state siting actions. Nuclear power plant licensing: a New England perspective.** Clark, P.B.; Neeley, J.H. Mar 1977. 78p. NTIS $5.00.

The U.S. Nuclear Regulatory Commission (NRC) has undertaken to study "Efficiency in Federal/State Siting Actions," using "siting" to include all non-radiological issues involved in the licensing of nuclear power plants. The NRC has commissioned the Center for Energy Policy, Inc. (CEP) to study the licensing process from the New England perspective. The CEP convened a task force of persons experienced in the licensing of nuclear plants and, with their assistance, prepared this report. The task force has gone somewhat beyond the scope of the larger study in that it has also considered radiological issues now within the exclusive jurisdiction of the NRC.

713 (NUREG—0321) **Study of the Nuclear Regulatory Commission quality assurance program.** Muller, F.W. Aug 1977. Contract EY-76-C-04-0789. 117p. Dep. NTIS, PC A06/MF A01.

Recommendations from a three month study are presented for quality assurance in nuclear power plants as it is practiced in industry and regulated by the NRC. Requested by the NRC, the study was accomplished through on-site visits by Sandia personnel at NRC offices and industry locations and through discussion with relevant technical society groups and interested individuals. The study group recommended changes to improve QA regulation by the NRC, to improve industry application of 10CFR50, Appendix B criteria, and to extend and expand the scope of QA activities by both industry and NRC.

714 (NUREG/PRDI—77/9) **Power Reactor Docket Information.** Sep 1977. 133p. TIC $3.70.

Citations and subject indexing to the documentation associated with civilian nuclear power plants are presented. This material is that which is submitted to the U.S. Nuclear Regulatory Commission in support of applications for construction and operating licenses. Citations are listed by Docket number in accession number sequence. The Table of Contents is arranged both by Docket number and by nuclear power plant name.

715 Suit against Kernkraftwerk Grafenrheinfeld rejected. 27: No. 6, 444-468(Jul 1977). (In German).

The administrative court at Wuerzburg, in its judgment of March 25th, 1977, - No. W 115 II 74 - has rejected with costs the action of the town of Schweinfurt against the Free State of Bavaria, the suit having been filed to cancel the licence of June 21st, 1974, for the construction of the Kernkraftwerk Grafenrheinfeld. Previously, the application to restore the suspensive power of the action (construction-stop) had already been rejected in the 2nd instance. The licence has been granted for the Bayernwerk AG as its future operator and for Kraftwerk Union AG as the manufacturer of the nuclear power plant. The decision has now been delivered with grounds upon which the judgment was based. It is not known yet whether the town of Schweinfurt will appeal. Costs were set at DM 150,000. The written grounds are given in full.

716 Announcement of the draft of a regulation concerning safety by the Kerntechnische Ausschuss. 29: No. 56, 2(Mar 1977). (In German).

Contenet are presented of the draft KTA 3201.1 'Components of the primary circuit of LWR reactors - Part 1: Materials.' The draft guideline deals with the demands made on metallic materials for rated operational temperatures up to 400°C.

717 Guidelines on the information required for judgment in the nuclear licensing procedure. 28: No. 5, 66-67(Feb 1977). (In German).

Guidelines are presented for documentation of the type but not the contents of the information concerning the design, the beginning of 1) the erection of buildings, 2) the installation of machine systems, 3) the installation of electrotechnical components, the start-up and trial operation of the reactor plant, and its continuous operation.

718 Stop-to-building decision concerning Brokdorf. 27: No. 1, 75-76(Jan 1977). (In German).

The petition of three boroughs and several citizens within the vicinity of the Rrokdorf nuclear power plant was answered by the administrative court of Schleswig-Holstein with its decision of December 15th, 1976 - 10 D 176/76 - according to which the suspensive power of the action against the 1st partial lincese on the basis of article 80 section 5 VW GO has been restored until such a time when the final decision in these proceedings will have been passed. Some of the grounds upon which judgment is based are presented in full.

719 Federal Minister for Research Hans Matthoefer on nuclear energy. No. 1, 6-12(1977). (In German).

Excerpts of a speech held by the Federal research minister on a conference of his party in November 1976. The speech included detailed statements on nuclear energy and on problems in connection with its application.

720 Companies holding nuclear certificates of authorization. New York; American Society of Mechanical Engineers (1977). 48p. .

A listing of companies holding Nuclear Certificates of Authorization for the manufacture of materials and components for nuclear service is presented.

721 Role of codes and standards in improving nuclear reliability. Landis, J.W. pp 164-172 of In Nuclear safety, 1975. Hetrick, D.L. (ed.). Hinsdale, IL; American Nuclear Society (1975).

From ANS topical meeting on nuclear safety; Tucson, Arizona, USA (5 Oct 1975).

See CONF-751044—.

The use of standards in the nuclear industry to improve the reliability and availability of nuclear power plants is discussed.

ECONOMICS

REFER ALSO TO CITATION(S) 1000

722 World energy provision; future role of nuclear energy. 1: No. 7, . 197-204(Jul 1977). (In Dutch).

A concise report on the lecture delivered by Haefele (IIASA) at the Salzburg Conference in May 1977, arranged by the IAEA is given by the observer from the Netherlands Energy Research Centre. The decision tree for peaceful developments in the field of nuclear energy is reproduced and the opinions of the participating countries are mentioned. An insertion on Alvin Weinberg's speech 'Nuclear Energy at the Turning Point' is added. The main points of the final discussion are outlined.

723 Nuclear energy in developing countries. 1: No. 7, . 235-239(Jul 1977). (In Dutch).

At the 1977 Conference in Salzburg the nuclear programmes of developing countries and the possibilities for their realisation were discussed. The cooperation of industrialised countries and the transfer of technological know-how were the main points in the survey presented by a Dutch observer to the conference.

724 Development of nuclear energy. Teller, E. (Stanford Univ., Calif. (USA). Hover Inst.). **76**: No. 12, 379-381(Jun 1977). (In German).

From VDEW meeting; Muenchen, Germany, F.R. (24 May 1977).

In his statements the author gives his views on the following subjects: firstly nuclear energy in the world context; second the type of reactor which can best be adapted to conditions in the future, with special reference to Germany; third the question about which has been heard much and to which the author has given his attention for 30 years, i.e. the safety of nuclear reactors; fourth and finally, his failure to understand the source of the opposition which would forbid the requisite nuclear installations.

725 Between research and energy production. Kirbus, F.B. **31**: No. 14, 24-25(Apr 1977). (In German).

1 fig.

When on March 20th, 1974, the nuclear power plant in Atucha, 100 km to the north-west of Argentine's capital Buenos Aires, built by Siemens, was taken into operation, it seemed as if South America had resolutely stepped into the atomic age. In the meantime, Brazil makes preparations for fortified construction of nuclear power plants and its own nuclear industry, and Mexico is accelerating its investigations in order to replace its dwindlung hydroelectric reserves as soon as possible with nuclear energy. The effect of the oil crisis was that Latin American countries, too, take a different look at the peaceful uses of atomic energy.

726 Atomic power development in USA. Its role of industry and government. Wiggin, E. (Atomic Industrial Forum, Inc., New York (USA)). No. 9, 91-101(1976). (In Japanese).

From 9. annual conf. of the Japan Atomic Industrial Forum; Tokyo, Japan (10 Mar 1976).

Many problems concerning the atomic power development in USA are investigated and discussed. (Introduction of fast breeder reactors is not considered in this paper). The first problem is the raising of capital for plant construction. The second problem is the supply of uranium. Estimated amount of yellow cake and its price are presented and compared with estimated demands. It is concluded that $3.5x10^6$ tons of yellow coke is sufficient for generating $7x10^8$KW of electric power up to about 2000. The third problem is the enrichment service. Balance of supply and demand is discussed together with the projected extension of existing plants and the construction of new plants. The completion of nuclear fuel cycle is discussed as the fourth problem. According to the author's opinion, technological problems of reprocessing, storing, waste disposal, and the utilization of mixed oxide fuel are not difficult to solve. Definite judgement of NRC and ERDA is strongly required. The last problem discussed in this paper is the public acceptance. The movements of anti-nuclear groups and the opinion of general public are analyzed and the role of AIF in presenting information is discussed.

727 Scylla, Charaybdis, and the U.S. Nuclear Power Program. Dragoumis, P. (Potomac Electric Power Co., Washington, DC). pp 3-14 of In Nuclear power development and the fuel cycle. Farmakes, R. (ed.). Hinsdale, IL; American Nuclear Society, Inc. (1976).

From 1. Pacific Basin topical conference on nuclear development and the fuel cycle; Honolulu, Hawaii, United States of America (USA) (11 Oct 1976).

See CONF-761014—.

Like the Odysseus of Greek mythology, nuclear energy and therefore the energy security of the United States, is making a difficult passage through a strait lined with hazards. On one side is Scylla, the monster/rock hazard representing fear of nuclear power for its accident and proliferation risks. On the other side is Charybdis, a dangerous whirlpool characterizing the confusion and nuclear expansion-inhibiting uncertainty, created by inconsistent, unpredictable regulation, questions respecting international controls, closing the fuel cycle, enrichment, etc. Given the vital national U.S. stake in nuclear power, solutions to the problems inhibiting nuclear expansion must and will be found. While solutions are expected, acceleration of efforts is needed to assure a safe national course through the hazardous straits to U.S. energy security based on domestic sources.

CONSTRUCTION AND OPERATION

728 New Energy Centre Lingen and its effect on the town. Vehring, K.H. **27**: No. 1, 49-51(Jan 1977). (In German).

The erection of the Kernkraftwerk Lingen meant that another site prerequisite was created for industry to settle there. Besides the Kernkraftwerk Lingen, the power station Emsland of the Vereinigte Elektrizitaetswerke Westfalen AG was built. Block A with an electrical capacity of 55 MW supplies neighbouring chemical enterprises with process steam by turning out 120 t/h of steam. It was taken into operation in 1972. Blocks B and C, each with a capacity of 403 MW, were taken into service 1974 and 1975 respectively. The Kernkraftwerk Lingen and the power station Emsland are operated jointly.

FUEL CYCLE

REFER ALSO TO CITATION(S) 288, 299, 344, 355, 634

729 Fuel cycle. 1: No. 7, . 205-215(Jul 1977). (In Dutch).

A combined review of ten lectures on 'Supply of Nuclear Fuel and Fuel Cycle Systems' is presented by the observer from the Netherlands Energy Research Centre at the 1977 Salzburg Conference.

730 Problems of the fuel cycles of nuclear fuels. Schmidt-Kuester, W.J.; Wagner, H.F. (Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.)). **100**: No. 11, 460-468(Nov 1976). (In German).

12 figs.

A secured procurement with nuclear energy can be achieved only if a completely closed fuel cycle will be established. In the Federal Republic of Germany efforts are concentrated on the front end as well as on the back end of the fuel cycle. At the front end the main tasks are to secure uranium supply and to establish the necessary enrichment capacity. The German concept for the back end of the fuel cycle will provide for an integrated and co-located system for all necessary facilities including reprocessing, plutonium fuel fabrication, treatment, interim storage and final disposal of the radioactive wastes to be operational in the mid-80's. Responsibilities for establishing this system are shared between government and private industry. Government will provide for final waste disposal, industry will build and operate the other facilities. Another important point for the introduction of nuclear energy is to solve reliably the problems of protection of fissionable material, radioactive waste and nuclear facilities. German government has initiated respective activities and has started appropriate R+D-work.

731 Regional and global planning: the nuclear fuel cycle. Giambusso, A. (Energy Research and Development Administration, Washington, DC). pp 411-416 of In Nuclear power development and the fuel cycle. Farmakes, R. (ed.). Hinsdale, IL; American Nuclear Society, Inc. (1976).

From 1. Pacific Basin topical conference on nuclear development and the fuel cycle; Honolulu, Hawaii, United States of America (USA) (11 Oct 1976).

See CONF-761014—.

When considering the many possible regional and global cooperative ventures in the energy field, it is evident that no area demands greater attention or offers greater opportunities than the generation of nuclear power for peaceful purposes. This is due largely to advantages and concerns that are unique to the nuclear fuel cycle. The many facets and complexities of the nuclear fuel cycle, including problems of adequacy of supply, safety, security, and terminal waste disposal, make it increasingly evident that even the most technically advanced nations must rely on the resources, capabilities, and cooperation of others to exploit the nuclear option in a mutually advantageous and acceptable manner.

PROCESS HEAT REACTORS

REFER ALSO TO CITATION(S) 34, 49, 364, 365, 367, 665

732 (COO—2975-13) **Advanced Gas Cooled Nuclear Reactor Materials Evaluation and Development Program. Quarterly progress report, April 1, 1977—June 30, 1977.** 1977. Contract EY-76-C-02-2975. 42p. Dep. NTIS, PC A03/MF A01.

The objectives of this program are to evaluate candidate alloys of Very High Temperature Reactor (VHTR) Process Heat and Direct Cycle helium Turbine (DCHT) applications, in terms of the effects of simulated reactor primary coolant (impure helium), high temperatures, and long time exposures on the mechanical properties and structural and surface stability of selected candidate alloys. A second objective is to select and recommend materials for future test facilities and more extensive qualification programs. Work covered in the report includes completion of alloy selection for the screening tests. The alloys selected for potential VHTR Nuclear Process Heat (NPH) applications and for potential DCHT applications are listed. The present status on the simulated reactor helium loop design and construction and the design and construction progress on the testing and analysis facilities and equipment are discussed.

733 **Nickel-base alloys for nuclear process heat applications.** Bassford, T.H.; Hosier, J.C.; Lingenfelter, A.C.; Martin, J.M.; Wenschhof, D.E. (Huntington Alloys, Inc., WV). **26**: 201-202(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

734 **Materials requirements for intermediate heat exchangers in VHTR systems.** Ammon, R.L.; Buckman, R.W. Jr. (Westinghouse Advanced Energy Systems Div., Pittsburgh). **26**: 202-203(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

735 **Screening studies on materials for nuclear process heat systems.** Bates, H.G.A. (High Temperature Materials Program, Wimborne, Eng.); Johnson, W.R.; Lupton, D.F.; Rittenhouse, P.L.; Rosenwasser, S.N. **26**: 203-204(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

736 **Evaluation of high-temperature alloys for nuclear process heat applications.** Mittenbuhler, A. (GHT, Bensberg, Ger.); Probst, H.; Schuhmacher, D.; Schuster, H.; Theymann, W.; Wanzl, W. **26**: 204(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

737 **Test and development of heat exchanger alloys for nuclear steam gasification of coal.** Gala, A. (Mannesmann-Forschungsinstitut, Duisburg, Ger.); Kalwa, P.G.; van Heek, K.H.; Wanzl, W. **26**: 204-205(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

738 **Hot-gas duct in a high-temperature reactor.** Schmitt, J.; Heil, J. (to Gesellschaft fuer Hochtemperaturreaktor-Technik m.b.H., Bergisch Gladbach (Germany, F.R.)). German(FRG) Patent 2,542,967/A/. 31 Mar 1977. 9p. (In German).

2 figs.

The claim refers to an annular arrangement which is installed below a steam reformer in a hot-gas duct, forming the connection with the HTGR, in order to achieve a uniform temperature profile thus avoiding local overheating. Close to the steam reformer, other heat exchangers utilizing the process heat are arranged. To the inner wall of the annulus, radiation-absorbing substances (e.g. boron) are added. The inner and outer walls of the annulus have openings which are closed by removable plugs during reactor operation and serving for introducing tools and instruments.

NUCLEAR REACTOR TECHNOLOGY

REFER ALSO TO CITATION(S) 1032

739 **Validated analysis capability for the Nuclear Electric Utility.** Loewenstein, W.B. (Electric Power Research Inst., Palo Alto, CA); Moore, J.B. **26**: 217(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

THEORY AND CALCULATION

REFER ALSO TO CITATION(S) 1766

740 (EPRI-NP—346) **Sensitivity analysis of TRX-2 lattice parameters with emphasis on epithermal ^{238}U capture. Final report.** Tomlinson, E.T.; deSaussure, G.; Weisbin, C.R. Mar 1977. Contract W-7405-ENG-26. 127p. (ENDF—252). Dep. NTIS, PC A07/MF A01.

The main purpose of the study is the determination of the sensitivity of TRX-2 thermal lattice performance parameters to nuclear cross section data, particularly the epithermal resonance capture cross section of ^{238}U. An energy-dependent sensitivity profile was generated for each of the performance parameters, to the most important cross sections of the various isotopes in the lattice. Uncertainties in the calculated values of the performance parameters due to estimated uncertainties in the basic nuclear data, deduced in this study, were shown to be small compared to the uncertainties in the measured values of the performance parameter and compared to differences among calculations based upon the same data but with different methodologies.

741 **Homogenized-cell diffusion parameters from transport codes.** Bonalumi, R.A. (Ontario Hydro, Toronto); La Briola, F.; Pierini, G.C. **26**: 221-222(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

742 **Note on pin-cell homogenization.** Stamm'ler, R. (ASEA-ATOM, Vasteras, Sweden). **26**: 222-223(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

743 **Nodal coupling of heterogeneous pin cells.** Weiss, Z.; Stamm'ler, R. (ASEA-ATOM, Vasteras, Sweden). **26**: 223-224(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

744 **Inclusion of buckling approximations in finite element neutron transport methods.** McCoy, D.R.; Lewis, E.E.; Lee, M.J.; Briggs, L.L.; Blomquist, R.N. (Northwestern Univ., Evanston, IL). **26**: 226-227(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

745 **Fast factorization procedures solving the multidimensional reactor dynamics equations.** Bottoni, G.P. (CISE, Milano, Italy). **26**: 229-230(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

746 **Unique features of the BITNOD large-mesh code.** Norinder, O. (AB Atomenergi, Nykoeping, Sweden). **26**: 230(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

747 **Coarse-mesh finite difference methods applied to a large PWR core.** Moberg, L.; Solanilla, R. (Atomic Energy Organization of Iran, Tehran). **26**: 230-231(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

748 **Problems of data supply for fast reactor calculations.** Boehmer, B. (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (German Democratic Republic)). **20**: No. 4, 89-95(Apr 1977). (In German).

The status of work concerning the solution of data supply problems in fast reactor calculations are reviewed. In particular, determination of data needs, organization of collecting and estimating nuclear data, and problems of processing, checking and adjustment of the data are dealt with.

749 **Reactor physics computations. Chapter 4.** Shapiro, A. (Cincinnati Univ., Ohio (USA). Dept. of Chemical and Nuclear Engineering). pp 81-112 of In Elements of nuclear reactor design. Weisman, J. (ed.) (Cincinnati Univ., Ohio (USA). Dept. of Chemical

and Nuclear Engineering). Amsterdam, The Netherlands; Elsevier (1977).

Those reactor-core calculations which provide the effective multiplication factor (or eigenvalue) and the stationary (or fundamental mode) neutron-flux distribution at selected times during the lifetime of the core are considered. The multiplication factor is required to establish the nuclear composition and configuration which satisfy criticality and control requirements. The steady-state flux distribution must be known to calculate reaction rates and power distributions which are needed for the thermal, mechanical, and shielding design of the reactor, as well as for evaluating refueling requirements. The calculational methods and techniques used for evaluating the nuclear design information vary with the type of reactor and with the preferences and prejudices of the reactor-physics group responsible for the calculation. Additionally, new methods and techniques are continually being developed and made operational. This results in a rather large conglomeration of methods and computer codes which are available for reactor analysis. The author provides the basic calculational framework and discusses the more prominent techniques which have evolved.

750 Heat generation and transport. Chapter 6. Weisman, J. (Cincinnati Univ., Ohio (USA). Dept. of Chemical and Nuclear Engineering). pp 157-188 of In Elements of nuclear reactor design. Weisman, J. (ed.) (Cincinnati Univ., Ohio (USA). Dept. of Chemical and Nuclear Engineering). Amsterdam, Netherlands; Elsevier (1977).

A nuclear reactor designed for power generation is nothing more than a source of thermal energy. The generation of this energy and its removal from the reactor core is examined.

751 Thermodynamics of nuclear power systems. Chapter 3. Anno, J. (Cincinnati Univ., Ohio (USA). Dept. of Chemical and Nuclear Engineering). pp 49-80 of In Elements of nuclear reactor design. Weisman, J. (ed.) (Cincinnati Univ., Ohio (USA). Dept. of Chemical and Nuclear Engineering). Amsterdam, Netherlands; Elsevier (1977).

The conversion of nuclear energy to useful work follows essentially the same course as the conversion of thermal energy from fossil fuel to work. The thermal energy released in the reactor core is first transferred to the primary coolant which then generally transfers its heat to a secondary fluid. The secondary fluid serves as the working fluid in a heat engine. The author briefly examines the thermodynamic principles governing the operation of such engines, the major thermodynamic cycles used, and their application to nuclear power plants.

752 Effects of equilibrium xenon in multi-dimensional reactor core optimization. Leung, D.C.T. Urbana, IL; Univ. of Illinois (1977). 160p. University Microfilms Order No. 77-14,978.

Thesis (Ph. D.).

The understanding and applications of optimization techniques to multi-dimensional nuclear reactor problems are very limited. The concept of a curve constraint (one-dimensional constraint) has been extended to a surface constraint (two-dimensional constraint) by taking the variations of multiple integral performance indices. Two-group, one-dimensional reactor optimization problems with fissions in only one group are generalized to multi-group multi-dimensional problems with the presence of a nonlinear xenon term and with fissions in all groups. Two multi-group codes, the ODO (one-dimensional, four energy group optimization) code, and the TDO (two-dimensional, four energy group optimization) code, have been developed for the maximization of the power rating of a reactor assembly subject to three constraint sets with and without the effect of xenon. The three constraint sets are inequality constraints on the power density and on the allowable fuel concentration; inequality constraints on the fast flux and the allowable fuel concentration; inequality constraints on the power density and fuel concentration, and an interior point constraint. The numerical scheme of the two codes is discussed. Numerical results which give the optimal fuel distributions for optimization problems are obtained and comparisons made for each problem with and without the effect of xenon. The stability and convergence of the iterative scheme are discussed and shown numerically. Recommendations for future work are made.

753 Two-dimensional kinetic equation calculation of a reactor by the finite element method. Isaev, N.V.; Slesarev, I.S.; Gorbatov, N.E.; Ivanova, A.P. **41**: No. 6, 391-395(Dec 1976). (In Russian).

For English translation see the journal Sov. At. Energy.

In this paper, the authors describe the triangular mesh algorithm for the two-dimensional multigroup neutron transport equation calculation of a nuclear reactor with hexagonal fuel elements by the method of finite elements. It is assumed that the neutron flux and source within the triangular cells have the form of a plane. ALGOL-60-code "Tri", which realizes this algorithm for computer BESM-6, is presented. The described method is illustrated by the example of a fast physical assembly calculation.

754 Experimental study on the effect of internal moderators in annular fuel elements on resonance capture in uranium. Kisil', I.M.; Lyubchenko, V.F.; Markelov, I.P.; Orlov, V.V.; Frolov, V.V.; Sharapov, V.N. **41**: No. 6, 99-402(Dec 1976). (In Russian).

For English translation see the journal Sov. At. Energy.

The results of experiments in determining the effect of scattering of moderators in the internal cavity of an annular uranium block on resonance capture in ^{238}U are presented. The effect is determined by the change in activation of a ^{235}U indicator on the inner surface of the annular uranium block when the moderator-under-investigation is inserted in its cavity.

755 New brief diffusion scheme for three-dimensional calculation of a BWR core. Tsuiki, M.; Aoki, K.; Yoshimura, S.ri (Nippon Atomic Industry Group Co. Ltd., Tokyo). **13**: No. 10, 541-554(Oct 1976).

A modified one-group diffusion scheme and a coarse-mesh diffusion method were newly developed independently, and are combined together to make an effective brief scheme for the solution of few-group diffusion equation in a 3-dimensional BWR core. In the above two methods, the local spatial behavior of the neutron spectrum-the ratio of thermal neutron flux to the fast neutron flux-and of the fast neutron flux within a volume element are approximately taken into account by using analytical procedures, therefore the resultant numerical equation, which is slightly more complicated than those of the conventional brief schemes, gives sufficiently accurate results. The special behavior of the spectrum in the neighborhood of the core-reflector interface is also treated. An analytical expression for the spectrum on the core-reflector boundary of various shapes is derived and some numerical examples are presented. The results obtained from a series of test calculations indicate that the method assures an accuracy comparable to the standard few-group fine-mesh finite-difference calculation without requiring much more computing time than those of the conventional brief calculation methods. Thus the method is particularly suited for improving the computational accuracy of the BWR simulation codes.

756 Evaluation of duct streaming calculations. Comparison with Monte Carlo method. Aoki, T.; Nakamura, H. (Fuji Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). No. 82, 61-66(Aug 1976). (In Japanese).

The evaluation of duct streaming calculation by the ray analysis method was performed, and the results were compared with the results by the Monte Carlo method. Formulas were given for the cylindrical duct streaming and the annular duct streaming. The code MORSE-J was used for the Monte Carlo calculation. Practical calculation was performed for 7 MeV fast neutron streaming through a cylindrical duct with the radius of 5 cm and the length of 1 m and that through an annular duct with the inner diameter of 10 cm, the outer diameter of 20 cm and the length of 1 m. In a cylindrical duct in water system, the component of the line of sight is the largest component, accordingly this component is good enough for the calculation. In a cylindrical duct in iron system, the effect of scattering must be considered, and the ray analysis method is not good for the calculation. However, at the point 50 cm apart from the exit of a duct, the component of the line of sight is good enough. In an annular duct, the component of the line of sight is good for the calculation since the effect of scattering is small. As a concluding remark, it is said that the case-by-case consideration of the calculation method is necessary.

757 Short criterion of criticality discrimination for a reactor core with control rods. Koga, R. (Kyoto Univ., Uji (Japan). Inst. of Atomic Energy). No. 169, 1-6(Jul 1976).

A concise criticality-determinant criterion is developed for a nuclear reactor core that is equipped with a small number of control rods which are pointwisely concentrated compared with the total core size. Result is described in a series form in terms of absorption intensity of each rod. Numerical test calculation shows that only the lowest few terms of the series gives good approximation.

COMPONENTS AND ACCESSORIES

REFER ALSO TO CITATION(S) 566, 572, 841, 878, 1310

758 (AD-A—040112) Creep of concrete under various temperature, moisture, and loading conditions. Final report. McDonald, J.E. May 1977. 30p. (WES-MP-C—77-3). NTIS PC A03/MF A01.

An investigation was conducted to develop information on the time-dependent deformation behavior of concrete in the presence of temperature, moisture, and loading conditions similar to those encountered in a prestressed concrete reactor vessel. Variables were one concrete strength (6000 psi (41 MPa) at 28 days), three aggregate types (chert, limestone, and graywacke), one cement (Type II), two types of specimens (as-cast and air-dried), two levels of temperature during test (73 F and 150 F (23 C and 66 C)), and four types of loading (uniaxial, hydrostatic, biaxial, and triaxial). There were 66

test conditions for creep tests and 12 test conditions for unloaded or control specimens. Experimental results are presented and discussed. Comparisons are made concerning the effect of the various test conditions on the behavior of concrete and general conclusions are formulated. (Author)

759 (CONF-770401—28) **Shielding methods development in the United States.** Mynatt, F.R. 1977. Contract W-7405-ENG-26. 13p. Dep. NTIS, PC A02/MF A01.

From 5. international conference on reactor shielding; Knoxville, Tennessee, United States of America (USA) (18 Apr 1977).

A generalized shielding methodology has been developed in the U.S.A. that is adaptable to the shielding analyses of all reactor types. Thus far used primarily for liquid-metal fast breeder reactors, the methodology includes several component activities: (1) developing methods for calculating radiation transport through reactor-shield systems; (2) processing cross-section libraries; (3) performing design calculations for specific systems; (4) performing and analyzing pertinent integral experiments; (5) performing sensitivity studies on both the design calculations and the experimental analyses; and, finally, (6) calculating shield design parameters and their uncertainties. The criteria for the methodology are a 5 to 10 percent accuracy for responses at locations near the core and a factor of 2 accuracy for responses at distant locations. The methodology has been successfully adapted to most in-vessel and ex-vessel problems encountered in the shield analyses of the Fast Flux Test Facility and the Fast Flux Test Facility and the Clinch River Breeder Reactor; however, improved techniques are needed for calculating regions in which radiation streaming is dominant. Areas of the methodology in which significant progress has recently been made are those involving the development of cross-section libraries, sensitivity analysis methods, and transport codes.

760 (ORNL/NUREG/TM—116) **Analysis of owner design specifications for snubbers. Report 2.** Butler, J.H. 5 Aug 1977. Contract W-7405-ENG-26. 24p. Dep. NTIS, PC A02/MF A01.

The report discusses and evaluates the adequacy of buyer specifications for snubbers. Technical specifications for snubbers (hydraulic and mechanical) were studied in detail in an effort to define the "fundamental needs" of the industry with respect to characteristics of snubbers during operation. In the course of this study, it was determined that there is insufficient consensus among users to make such a definition. Authorities in the fields of structural dynamics, structural systems design, and snubber design were also consulted for additional information. Information from these sources is incorporated to identify the fundamental areas of concern, areas where consensus is lacking, and problems to be resolved in order to establish meaningful standards for this equipment.

761 (ANL-Trans—1098) **System to reduce the hazards of a reactor core meltdown.** Barleon, L.; Dorner, S.; Goetzmann, O.; Kussmaul, G. Aug 1977. Translated from German Patent 2,363,845. 9p. Dep. NTIS, PC A02/MF A01.

The core catcher is realized by the fact that at least on the inner side facing the reactor core it consists of at least one high-melting material from the group of graphite, carbides and material combinations of graphite fibers and/or filaments with carbides, borides and/or silicides. The core catcher can consist completely of pressed high-density graphite or of metal with a lining of pressed high-density graphite. In an improvement of the invention, the core catcher is provided with a lining of carbides or of a material combination of graphite fibers and/or filaments with carbides, borides and/or silicides. It is an advantage if the lining is provided with a metallic clad which is inactive in the presence of the coolant under normal reactor operating conditions. This cladding can consist of high-grade steel. In a further improvement of the invention, the graphite core catcher or the high-grade steel core catcher with a graphite lining is provided with a coating of boron carbide or boron nitride on the side facing the reactor.

762 **Apparatus for treating an exhaust gas from nuclear plant.** Kamiya, K.; Yusa, H.; Nakajima, F.; Takeuchi, M. (to Hitachi, Ltd.). US Patent 4,038,060. 26 Jul 1977. Priority date 1 Dec 1972, Japan. 8p.

In an apparatus for treating an exhaust gas from a nuclear plant which comprises a container and a cryogenic distillation apparatus disposed in the container for liquefying and separating a radioactive gas therefrom, an adsorbent such as an active carbon is filled in the container to surround the cryogenic distillation apparatus whereby leakage of the radioactive gas on the occasion of an accident can be removed.

763 **Apparatus for examining the fuel rods of a nuclear reactor.** Weilbacher, J.C.; Bodson, G. (to Societe Franco-Americaine de Constructions Atomiques-Framatome). US Patent 4,036,686. 19 Jul 1977. Priority date 22 Jan 1975, France. 6p.

Apparatus for visually examining the fuel rods of an assembly of fuel rods immersed in the tank of a nuclear reactor or in a deactivation tank is described which comprises an endoscope including a prism and an optical system of stabilized glass, and at least one arm supporting a mirror facing the prism and inclined relative to the plane defined by the axis of the tube of the endoscope and the arm, the thickness of the arm-mirror assembly being less than the free space between the rods of the assembly. In use the apparatus is mounted on a system of carriages which enable the apparatus to move in three perpendicular directions, the carriages being associated with rotatable means for supporting an assembly of rods to be examined.

764 **Welding and weld seam inspection of reactor components.** Link, M. (Kraftwerk Union A.G., Erlangen (Germany, F.R.). Reaktortechnik). **19**: No. 7, 301-306(Jul 1977). (In German, English).

From Reactor congress 1977; Mannheim, Germany, F.R. (29 Mar - 1 Apr 1977).

6 figs.; 2 tabs.; 10 refs.

The comprehensive surveillance and in-process inspections of weld seams of components of the nuclear steam supply system (NSSS) ensure a sufficient integrity of these components. This report shows that the stringent specifications of the Reactor Safety Commission are fulfilled and that repeated non-destructive examinations result in a redundant quality assurance of the weld seams.

765 **Quality control of welding filler materials for reactor technology.** Meyer, R. (Messer Griesheim G.m.b.H., Frankfurt am Main (Germany, F.R.)). **19**: No. 7, 307-310(Jul 1977). (In German, English).

2 figs.

The regulations applicable to the quality control of welding filler materials intended for use in nuclear technology are contained in VdTUeV memorandum 1753 and ASME Code Section III. The document explains how the two sets of regulations are applied to the manufacture of coated stick electrodes. The requirements and procedures to be carried out before, during and after production are defined and attention is drawn to the most important differences between the VdTUeV and ASME regulations.

766 **Experience leads to major advances in reactor pressure vessel design.** Ishikawa, K.; Ando, E. (Ishikawajima-Harima Heavy Industries Co. Ltd., Tokyo (Japan)). **22**: No. 259, 49-53(Jul 1977).

Some of the advances in design of reactor pressure vessels resulting from the increasing stringent reliability requirements are discussed. Reduction in the number of weld seams reduces cost of both in-service inspection and fabrication. Stricter control of impurity elements in base material and welding material was achieved in order to apply the reference temperature method of measuring fracture toughness. Investigations following the discovery of cracks on feedwater sparges and nozzles led to further research on stress and fracture analysis. Improved overlay welding techniques were developed to eliminate cracking of the underlay. New techniques were also developed to prevent stress corrosion cracking of stainless steel. A new method of weld repairing to avoid hydrogen cracking is proposed.

767 **Damage to pipes and fittings in live steam plants. Test results, causes and prevention.** Burgbacher, G.; Kattoll, F.W. (Technischer Ueberwachungs-Verein Stuttgart e.V. (Germany, F.R.)). **57**: No. 6, 434-441(Jun 1977). (In German).

17 figs.; 1 tab.; 17 refs.

The authors report on salient damages having occurred recently in the area of a Technical Control Board. By means of some representative damages, the attempt is made to establish certain trends concerning the materials and the operating conditions, and to draw conclusions for existing and future plants. Special features are dealt with, the effects of which have an essential bearing on the prevention of damages.

768 **ASTM activities in the simulation of radiation effects.** Kramer, D. (Atomics International, Canoga Park, CA). **26**: 193(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

769 **Irradiation creep of reactor materials during 4-MeV proton bombardment.** McElroy, R.J. (Univ. of Oxford); Hudson, J.A. **26**: 195(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

770 **Rationale for in-service inspection during nuclear power plant design/fabrication.** Dau, G.J. (Electric Power Research Inst., Palo Alto, CA). **26**: 206-207(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

771 Correlation of high- and low-cycle fatigue data for solution-annealed Type 304 stainless steel. Soo, P.; Chow, J.G.Y. (Brookhaven National Lab., Upton, NY). **26**: 211(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

772 Solution to an infinite elastic continuum penetrated by an elastic tube with different physical properties. Battenbo, H. (Whessoe Ltd., Darlington (UK)). **41**: No. 2, 231-246(Apr 1977).

An exact analytical solution has been obtained, by means of the complex stress-function method, to the problem of a homogeneous isotropic infinite elastic continuum subjected to a general biaxial stress field and containing a hole reinforced by a 'thick' elastic prismatic tube, also homogeneous and isotropic, which has different elastic properties. The solution was so complicated and required such a high order of numerical accuracy that a computer program was written to perform all the necessary arithmetic and evalute stresses and deflections at any point in the tube or continuum. The work has been checked by investigating limiting values of various parameters and by comparison with finite element models using the PAFEC program. The solution was obtained in support of the problem of a concrete vessel carrying a general biaxial stress field which is penetrated by a steel tube.

773 Plastic buckling of a steel liner encased in a concrete cylinder. Moon, Y.I.; Kicher, T.P. (Case Western Reserve Univ., Cleveland, Ohio (USA)). **41**: No. 2, 281-291(Apr 1977).

The inelastic buckling and postbuckling performances of a steel liner encased in a rigid concrete containment vessel are studied by taking a strip of unit width from a pattern - either rectangular or diamond - along the circumferential direction in such a way that the strip will have the maximum deflection of a buckled panel. The complete load-deflection curves are obtained and the effect of initial imperfections is also included in the curves. From the discussion of failure modes, a design criterion can be obtained for the liner to maintain its integrity under accident conditions. A simplified spring model is used to calculate the maximum shear displacement and the corresponding shear force of studs at buckling. A design analysis procedure is developed from the limit and the ultimate design conditions and can be used to determine the liner thickness, stud sizes, and stud spacings in both the axial and circumferential directions.

774 Constructional assessment and strength test of pipings in nuclear power stations. Pt. 2. Elter, C. **18**: No. 3, 95-100(Mar 1977). (In German).

9 figs.; 1 tab.; 3 refs.

In TUeV assessments of piping systems, carried out on behalf of the licensing authorities in the field of nuclear engineering, special demands are made on materials selection, design, strength calculations and construction surveillance. In order to prevent pipe ruptures caused by exceeding the creep rupture or fatigue strength, load cycles, especially due to temperature transients at various states of operation, should be determined in addition to the proper selection of materials in addition to the usual dimensioning calculations, and the stress analysis based on all possible loads should be supplemented by a fatigue analysis. Recent calculations also give interesting hints as to which points should be observed in particular in addition to the usual construction surveillance measures during assembling and start-up.

775 Cooling tower make-up water processing for nuclear power plants: a comparison. Andres, O.; Flunkert, F.; Hampel, G.; Schiffers, A. (Rheinisch-Westfaelisches Elektrizitaetswerk A.G., Essen (Germany, F.R.)). **29**: No. 1, 6-13(Jan 1977). (In German).

7 figs.; 11 refs.; with tabs.

In water-cooled nuclear power plants, 1 to 2% of the total investment costs go to cooling tower make-up water processing. The crude water taken from rivers or stationary waters for cooling must be sufficiently purified regarding its content of solids, carbonate hardness and corrosive components so as to guarantee an operation free of disturbances. At the same time, the processing methods must be selected for operational-economic reasons in such a manner that waste water and waste problems are kept small regarding environmental protection. The various parameters described have a decisive influence on the processing methods of the crude water, individual processes (filtration, sedimentation, decarbonization) are described, circuit possibilities for cooling water systems are compared and the various processes are analyzed and compared with regard to profitableness and environmental compatability.

776 Nuclear reactor shielding. Chapter 5. Moteff, J. (Cincinnati Univ., Ohio (USA). Dept. of Materials Science and Metallurgical Engineering). pp 113-156 of In Elements of nuclear reactor design. Weisman, J. (ed.) (Cincinnati Univ., Ohio (USA). Dept. of Chemical and Nuclear Engineering). Amsterdam, Netherlands; Elsevier (1977).

Reactor shielding is necessary not only for (a) the protection of personnel working in close proximity to the nuclear reactor system, but also to (b) reduce radiation levels in the vicinity of instrumentation and other equipment which may be damaged by radiation, (c) reduce the induced radioactivity of reactor components which may need to be serviced during shutdown, (d) prevent excessive radiation-induced heating of the reactor-vessel, and (e) limit the neutron embrittlement of the reactor vessel. The chapter considers the radiation released by a reactor and the interaction of this radiation with matter. Some of the methods which may be used for shield design are then considered.

777 Fluid system design. Chapter 7. Rust, J.H. (Georgia Inst. of Tech., Atlanta (USA). School of Nuclear Engineering). pp 189-223 of In Elements of nuclear reactor design. Weisman, J. (ed.) (Cincinnati Univ., Ohio (USA). Dept. of Chemical and Nuclear Engineering). Amsterdam, Netherlands; Elsevier (1977).

Since nuclear-reactor heat is generally removed by a moving fluid, it is necessary to design a fluid system to accomplish this. The fluid system design must consider steady-state and transient operation and include component pressure losses, flow distributions, and pumping power requirements. In addition, flow stability problems may occur under two-phase flow conditions. Steady-state conditions are considered.

778 Heat transfer. Chapter 8. Rust, J.H. (Georgia Inst. of Tech., Atlanta (USA). School of Nuclear Engineering). pp 225-254 of In Elements of nuclear reactor design. Weisman, J. (ed.) (Cincinnati Univ., Ohio (USA). Dept. of Chemical and Nuclear Engineering). Amsterdam, Netherlands; Elsevier (1977).

Removal of the heat generated within the reactor core is one of the major problems encountered in power reactor design. This is due primarily to reactor-core power densities being orders of magnitude higher than in most conventional heat sources. Producing heat in reactor cores presents no difficulty. The problem is heat removal without excessively high temperatures inside fuel elements or on their surfaces. Thermal performance limitations are established such that fuel-element integrity will be maintained. The reactor thermal analysis then establishes the maximum power level at which this can be accomplished. The task may be divided into two segments: (1) Steady-state analysis - mapping of temperature distributions and heat transfer rates during normal full-power operation. (2) Transient analysis - mapping temperature distributions during various system transients. Only the steady-state analysis is considered.

779 Elements of stress analysis. Chapter 9. Weisman, J. (Cincinnati Univ., Ohio (USA). Dept. of Chemical and Nuclear Engineering). pp 255-265 of In Elements of nuclear reactor design. Weisman, J. (ed.) (Cincinnati Univ., Ohio (USA). Dept. of Chemical and Nuclear Engineering). Amsterdam, Netherlands; Elsevier (1977).

In order to understand the design methodology applied to vessels, piping and fuel elements, and acquaintance with stress analysis is required. A brief overview of the basic principles of stress analysis is therefore presented.

780 Vessel and piping design. Chapter 10. Weisman, J. (Cincinnati Univ., Ohio (USA). Dept. of Chemical and Nuclear Engineering). pp 267-302 of In Elements of nuclear reactor design. Weisman, J. (ed.) (Cincinnati Univ., Ohio (USA). Dept. of Chemical and Nuclear Engineering). Amsterdam, Netherlands; Elsevier (1977).

The vessels and piping of a nuclear-reactor plant must be capable of safely withstanding the loadings placed upon them by the high-pressure coolant which they contain and the heat which may be generated within their walls. It is shown how these loadings may be determined and the standards which are applied to assure conservative design are examined.

781 Quality assurance for large machines. Kron, A.W. **59**: No. 6, 219-225(1977). (In German).

10 figs.; 1 ref.

Quality assurance is mainly intended to avoid the occurence of defects and failures. In addition to the materials and production tests, a supporting measure is the supervision of the products in service to allow defects ascertained during operation to be eliminated in new designs. The article describes the quality assurance system adopted by BBC in the production of large machines.

782 Flywheel with burst protection device. Hintergraeber, M. (to Kraftwerk Union A.G., Muelheim an der Ruhr (Germany, F.R.)). German(FRG) Patent 2,405,723/C/. 11 Nov 1976. 5p. (In German).

4 figs. Addition to P2338265.2.

A flywheel is described with burst protection device for protection against excess speed which is fitted by shrinking into a shaft section in the shape of a truncated core, in which a force affects the flywheel in the direction of the face of the shaft section

with the smaller diameter and in which a catch and/or centering device is provided for the flywheel.

783 Automatic ultrasonic inspection for welding piping of nuclear power plant. Sakurai, Y.; Yamada, H.; Kaneko, J. (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan)); Uchida, K. **25**: No. 11, 712-719(Nov 1976). (In Japanese).

The new drive mechanisms and recording method were developed for the Inservice Inspection of small size pipings in nuclear power plants, and for the improvement of the reliability for the detection of weld defects. Three new drive mechanisms were developed, which are easily available to inspect any different type of pipings by one probe head with many probes. The inspection data are recorded on the pen recorder and multidisplayed on monitor by CRT to be easily evaluated. The reliability of mechanisms were evaluated for inspection methods such as the lineality the influence of the drive velocity, etc.

784 Inservice inspection and problems in Japan. Ishikawa, K. (Ishikawajima-Harima Heavy Industries Co. Ltd., Tokyo (Japan)). **18**: No. 11, 696-700(Nov 1976). (In Japanese).

Inservice Inspection (ISI) for nuclear power plants is steadily progressing in Japan. Philosophy and technology of ISI has been introduced from the U.S.A. In application of ISI to the plants in Japan, potential problems have been revealed as, for example, discrepancies between the engineering requirements for component manufacturing and ISI, slow progress of development of ISI equipment and so on. The problems of codes and regulations such as Section XI of ASME Code are discussed in relation with the actual application in Japan.

785 Telescopic device, especially for nuclear facilities. Rheinhardt, H. (to Kraftwerk Union A.G., Muelheim an der Ruhr (Germany, F.R.)). German(FRG) Patent 2,510,062/A/. 21 Oct 1976. 9p. (In German).

1 fig.

A telescopic device is described which is to be used for inspection of nuclear power installations and therefore must work especially reliably. The telescopic device consists of at least three tubes, inserted into one another, which, in preset succession, are to execute movements in longitudinal direction relative to each other, limited by stops. According to the invention a guided succession of the relative movements of the bodies is achieved by arranging locking bodies within clearances at the end of the tubes which, together with stopping bodies and projections, enforce that only one tube at a time can execute a movement relative to the other. A very informative presentation explain the technical details.

786 Methods for predicting isochronous stress-strain curves. Kiyoshige, M. (Kawasaki Heavy Industries, Ltd., Kobe (Japan). Technical Research Lab.); Shimizu, S.; Satoh, K. No. 82, 48-53(Aug 1976). (In Japanese).

Isochronous stress-strain curves show the relation between stress and total strain at a certain temperature with time as a parameter, and they are drawn up from the creep test results at various stress levels at a definite temperature. The concept regarding the isochronous stress-strain curves was proposed by McVetty in 1930s, and has been used for the design of aero-engines. Recently the high temperature characteristics of materials are shown as the isochronous stress-strain curves in the design guide for the nuclear energy equipment and structures used in the high temperature creep region. It is prescribed that these curves are used as the criteria for determining design stress intensity or the data for analyzing the superposed effects of creep and fatigue. In case of the isochronous stress-strain curves used for the design of nuclear energy equipment with very long service life, it is impractical to determine the curves directly from the results of long time creep test, accordingly the method of predicting long time stress-strain curves from short time creep test results must be established. The method proposed by the authors, for which the creep constitution equations taking the first and second creep stages into account are used, and the method using Larson-Miller parameter were studied, and it was found that both methods were reliable for the prediction.

787 Automatic all position welding for horizontally fixed tubes by tungsten inert gas arc welding method. Ukai, J.; Tetsu, T. (Mitsubishi Electric Corp., Tokyo (Japan)). **27**: No. 8, 755-758(Aug 1976). (In Japanese).

The welding of fixed tubes is mostly all position welding in restricted places, accordingly much skill is required. The automation of welding is necessary because of the requirement for the reliability of welded joints, the difficulty of securing skilled workers, and welding quality. The development and production of the automatic welders for TIG welding of tubes have been carried out by Mitsubishi Electric Corp., and the application to various purposes was attempted. The TIG welding for the automatic welding of tubes is advantageous, because backside bead can be formed stably, spatter does not arise, welding is stable for every metal, and the mechanism of the automatic welders is simple. But it is not suitable for the welding of zinc-plated tubes, and the rate of deposition is relatively small. It is applied to the welding of boiler tubes, nuclear energy equipments and pipings, chemical equipments and pipings, and aluminum pipings. The specifications and the construction of the TIG tube welders are shown. The preparation of joints and the control of welding conditions are important for guaranteeing the welding results in automatic welding, therefore sufficient consultation with welder makers about these points is required. The welding defects apt to arise are the bad form of backside beads, blowholes, and the insufficient melting of intermediate layers, and the countermeasures to them must be taken.

788 Valve for closing a steam line. Meyer, W.; Potrykus, G. (to Deutsche Babcock und Wilcox A.G., Oberhausen (Germany, F.R.)). German(FRG) Patent 2,502,825/A/. 29 Jul 1976. 9p. (In German).

2 figs.

Instead of several control elements, the quick-closing valve, especially in the main-steam line between steam generator and turbine of a power station has the valve cone itself as the only movable part, acting with its inner surface as a piston within a second cylinder space. The valve shaft is at the same time a piston rod with a stepped piston at the upper end. This piston is loaded in a cylinder at the upspace below the valve cover on one hand by a spring, on the other hand by its own medium. Two non-return valves, one of it in a bore of the valve cone, connect the first-mentioned cylinder space with the steam-loaded inlet resp. outlet side of the valve. For controlling the valve, a magnet valve is sufficient. By automatic control of the valve cone coupled with several pistons several control lines can be omitted. There are also no pressurized control lines outside the valve which could be damaged by exterior influences.

789 Device for inspecting the inner surface of a nuclear reactor vessel. Bukrinskii, A.M.; Gladkow, J.K.; Kasakow, W.A.; Maksimow, L.P.; Mironow, W.N.; Schmelnickii, W.A.; Schabanow, N.N. (to Vsesoyuznyj Nauchno-Issledovatel'skij Teplotekhnicheskij Inst., Moscow (USSR)). German(FRG) Patent 2,203,406/C/. 26 May 1976. 3p. (In German).

1 fig.

The invention is concerned with details of the drive mechanism of a cylindrical cabin giving protection for the inspection of the interior of a nuclear reactor.

790 Prestressing methods for the construction of nuclear power plants. Woelfel, E. No. 257, 103-113(1976). (In German).

32 figs.

On building the THTR, prestressed concrete has been used in Germany for the first time for structures of nuclear power stations. The THTR pressure vessel not only encloses the core but also the steam generators. After reposting on the development of prestressed-concrete structures the author describes the tendons tied to buttresses used abroad for reactor containments up to now. Besides the different types of tendons, especially the different winding prestressing methods competing with each other are pointed out and tests of single tendons as well as on winding prestressing methods are discussed. The problem of possible corrosion resp. the corrosion protection achieved plays a particular role.

791 Plasma manual hardfacing on nuclear valves. Allen, J.B.; Bradley, J.W. (Westinghouse Electric Corporation (USA). Electro-mechanical Division). **21**: No. 3, 15-16(1976).

Nuclear energy production advances are essential to meeting projected world energy needs. Safe, continuous plant operation will guarantee the generation of this energy. Within nuclear power plants, valve service is critical to daily operation and maintenance and plant emergency controls. To increase nuclear stainless steel valve quality and reliability, the Westinghouse Electro-mechanical Division has selected manual plasma transferred arc hardfacing for three critical wear applications - backseat ring bore, gate wedge guide surface, and gate disc guide lug. The manual plasma process was initially compared with these alternatives - gas tungsten arc, shielded metal arc, and oxy-acetylene hardfacing. The considerations influencing process selection were: customer and engineering design requirements, materials, manufacturability, and relative costs. Process selection and implementation elements and current production controls have accomplished superior finished component quality.

792 Prestressed-concrete pressure vessel meeting on 13th/14th Oct. 1975 in Berlin. Bunke, N. No. 7, 182-183(1976). (In German).

From Conference on research and development for prestressed concrete for reactor pressure vessels; Berlin, Germany, F.R. (13 - 14 Oct 1975).

Report on the meeting on research and development of PCRVs organized by the 'Deutscher Ausschuss fuer Stahlbeton'. Research work is carried out on behalf of the Ministry for Research and Technology and supervised by the 'Deutscher Ausschuss fuer Stahlbeton'.

793 (ORNL-tr—4373) **Methods of measurement on a prestressed concrete pressure vessel with a hot liner in the Research Center at Seibersdorf.** Zemann, H. Aug 1975. Translation by S.D. Blalock Jr. of SGAE—2532. (CONF-750979—8). 20p. Dep. NTIS, PC A02/MF A01.

From 39. physics conference; Munich, F.R. Germany (1 Sep 1975).

The distribution of stress, strain, temperature and humidity within the structural concrete of the PCPV with hot liner at Seibersdorf Research Center is measured for safety surveillance and in order to prove the suitability as a reactor pressure vessel. A survey of the methods of measurement at elevated temperatures is presented.

794 **Fast closing valve, operated by pneumatic action, for pipelines for the transport of solid materials.** Schoening, J.; Handel, H.; Landwehr, H.; Lorenzen, H. (to Hochtemperatur-Reaktorbau G.m.b.H., Koeln (Germany, F.R.)). German(FRG) Patent 1,600,708/C/. 12 Jun 1975. 6p. (In German).

2 figs.

Valve designs previously known do not meet the stringent requirements in nuclear reactor application, e.g., to close pipelines for the transport of fuel elements which must permit operation over prolonged periods of time under completely tight conditions while requiring no maintenance. In the invention a closing valve is proposed in which the movable sealing elements, which are designed as pistons, are moved into their sealing positions by pneumatic action. A tension spring and a throttle cause it to be forced against its seat only after the piston has come to rest in its locked position. The fluid used to transport the solid is the same gas which is employed to pressurize the piston.

795 **Method of preventing diffusion of radioactive nuclear reaction products.** Uchida, S.; Kitamura, M. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-94099/A/. 17 Feb 1975. 5p. (In Japanese).

Object: To prevent the diffusion of radioactive nuclear fission products such as radioactive iodine or the like from a reactor pool. Structure: In light of the fact that the emission into the atmosphere of chiefly radioactive iodine from reactor liquid containing radioactive nuclear fission products such as radioactive iodine results from gas-liquid equilibrium through the surface of contact between the reactor liquid and air, a transparent fluid, such as fluid paraffin, which is insoluble in water, has a specific gravity less than that of water and is much less soluble than water with respect to iodine or the like, is poured onto a reactor liquid surface within the inner region of a flexible barrier floated on the reactor liquid surface to form a thin layer of the fluid over the reactor liquid surface, thereby forming a transparent fluid lid which permits the shape of the liquid surface to be readily changed. In this way, the reactor liquid containing radioactive iodine or the like is prevented from directly contacting the air, thus preventing the emission of the nuclear fission product into atmosphere.

796 **Investigation of a radioactive iodine-decontamination method for the N_2O_4-coolant.** Drugachenok, M.A.; Gol'tsev, V.P.; Datskevich, P.I.; Kuznetsova, N.B.; Dolgov, V.B. (AN Belorusskoj SSR, Minsk. Inst. Yadernoj Ehnergetiki). No. 4, 37-39(1975). (In Russian).

A plant and a circuit for coolant purification from radioactive iodine isotopes are described. The purification is accomplished by means of silica gel soaked with silver nitrate. The specific activity of the coolant during the experiments has been 3 μC/kg. The gamma spectrometry of a coolant sample using a semiconductor Ge(Li) spectrometer shows the sample activity to be due entirely to the ^{131}I isotope. By the end of measurements the obtained purification coefficient has been 22. The results of measuring the ^{131}I activity distribution along the experimental section length show the experiment to be not long enough for establishment of the stationary distribution that allows the adsorbent capacity to be determined and some conclusions to be drawn with regard to iodine state in the medium from which the adsorption takes place. The proposed measurement technique is very efficient. The chosen adsorbent in the from of granules of silica gel soaked with silver nitrate ensures a high degree of N_2O_4 coolant purification from radioactive iodine. Besides, the adsorbent is characterized by acceptable compatibility with N_2O_4 at the parameters of the experiment.

797 **Control of the turbo-generator frequency by ballast loading.** Kamenskaya, Z.V.; Pavlin, I.M.; Sharovarov, G.A. (AN Belorusskoj SSR, Minsk. Inst. Yadernoj Ehnergetiki). No. 2, 66-68(1975). (In Russian).

Regulation of the frequency of the turbogenerator of a low-power nuclear power generator using stabilizer loads is discussed. Mechanical and electrical stabilizer loads are considered. Transition processes at 100% collection of the available generator load are shown.

798 **Reactor protection reliability: a problem in extrapolation.** Gangloff, W.C. (Westinghouse Electric Corp., Pittsburgh). pp 153-163 of In Nuclear safety, 1975. Hetrick, D.L. (ed.). Hinsdale, IL; American Nuclear Society (1975).

From ANS topical meeting on nuclear safety; Tucson, Arizona, USA (5 Oct 1975).

See CONF-751044—.

Reliability of reactor protection is a subject which evokes extrapolation on at least two counts. First, the extremely low failure probability expected of the system forces one to go beyond system level experience and extrapolate from component data to obtain desired predictions of reliability. Second, the designer of reactor protection systems lives in the midst of evolving standards and regulatory criteria as well as evolving hardware to implement the criteria. The designer is forced to extrapolate beyond current practice in order to assemble a system which will satisfy the requirements of the reactor plant several years hence. The trend data relevant to such extrapolation are reviewed.

799 (ORNL-tr—4374) **Strain measurements in an expanded (stressed) concrete structure at temperatures up to 300°C.** Schittenhelm, C.; Angeli, R. 1975. Translation by S.D. Blalock Jr. of SGAE—2531. (CONF-750979—9). 27p. Dep. NTIS, PC A03/MF A01.

From 39. physics conference; Munich, F.R. Germany (1 Sep 1975).

Strain measurements in a concrete structure representing a cylindrical section of a prestressed concrete reactor vessel with hot liner were made. In order to interpret these values in terms of strain and stress in a three-dimensional structure, the gauge characteristics as well as the material date of the concrete have to be known in great detail. The performance of different gauges embedded in small concrete blocks and others of the same type embedded in the test ring is analyzed. Temperature resistance, long-term performance, electrical drift, hysteresis and accuracy of the gauges were investigated.

800 **Linear step electromagnetic drive.** Klyuev, V.F. USSR Patent 446908/A/. 15 Oct 1974. Filed date 14 Dec 1972. 3p. (In Russian).

A design is proposed for a linear stepping electromagnetic drive wherein the drive electromagnet for decreasing the pitch of a travelling control organ comprises several sections with similar working gaps equal to the ratio between the drawbar thread pitch and the number of sections. The operating principle of the drive is described.

801 **Zur Simulation des Regelverhaltens von Durchlaufdampferzeugern mit Hilfe von Modellbausteinen. (Simulation of the control behaviour of continous flow steam generators with the aid of model components).** Necker, P. (Stuttgart Univ. (TH) (Germany, F.R.). Inst. fuer Verfahrenstechnik und Dampfkesselwesen). Duesseldorf, Germany, F.R.; VDI-Verl. (1973). 130p. (In German).

80 refs.; with figs. and tabs.

For a simple predetermination of the dynamic behaviour of the water-steam part of continuous flow steam generators, model components of the various heating surface types (preheater, evaporator, superheater) are designed with simplified pressure dynamics. The model components in their basic concept are suited for analogous, hybrid, and also for digital simulation. The simple composition of an overall model for a continuous-flow steam generator by model components connected in series according to the arrangement of the finished steam generator, is shown especially with the digital simulation used in this paper. The parameters of the model components are evaluated only from data already known in the design stage of the steam generators. The model parameters for preheater and superheater heating surfaces are computed by a special approximation method with a digital computer code. The parameter calculation for the evaporator model components is directly performed in the simulation code. For model calculations over larger load ranges, a method with load-depending parameters is proposed.

FUEL ELEMENTS

802 (TID—26711-P2) **Fundamental aspects of nuclear reactor fuel elements: solutions to problems.** Olander, D.R. 1976. 573p. Dep. NTIS $13.50.

803 **Nuclear reactors.** Pearson, K.G. (to United Kingdom Atomic Energy Authority). US Patent 4,038,132. 26 Jul 1977. Priority date 17 Sep 1974, United Kingdom of Great Britain and Northern Ireland (UK). 4p.

In a nuclear fuel rod cluster in which the rods are supported axes parallel and held in spaced relationship by transverse grids, a number of auxiliary coolant spray pipes are positioned among the fuel rods. At least one grid has attached to it a target plate which

extends between the fuel rods to deflect auxiliary coolant sprays on to the surfaces of portions of the rods which would otherwise not be cooled by the spray.

804 Irradiation creep of Zircaloy under proton bombardment. Lucas, G.E. (Massachusetts Inst. of Tech., Cambridge); DiMarzo, J.T.; Surprenant, M.; Brown, G.J. **26**: 197-198(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

805 Oxidic nuclear fuel or fertile material for fuel and/or breeder subassemblies. Foerthmann, R.; Hamesch, M.; Nickel, H. (to Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.)). German(FRG) Patent 2,063,720/C/. 30 Dec 1976. 3p. (In German).

The invention deals with an oxidic nuclear fuel for reactor fuel and/or fertile elements consisting of a graphite matrix in which spherical fuel particles, coated with gas-impermeable pyrocarbon, are embedded. According to the invention, the latter contain up to 10 atom percent metal oxides with a low neutron capture cross section (e.g. Al_2O_3, niobium oxide), finely dispersed. These metal oxides serve to bind solid fission products inside the spheres in the form of complex metal oxides. An examplary arrangement for UO_2 fuel is described.

806 Effect of pre-hydriding on post-irradiation ring-tensile properties of Zircaloy-2 cladding tubes. Uchida, M.; Ichikawa, M. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). **13**: No. 10, 585-590(Oct 1976).

Zircaloy-2 tubes were hydrided up to a nominal content of 200 ppm and irradiated as fuel claddings in HBWR. Post-irradiation ring-tensile testing revealed that hydrogen enhances the irradiation-induced decrease of elongation and wall thickness reduction at room temperature. On the other hand, no effect of hydrogen was observed on ultimate tensile strength. With testing at 300°C, the effect was negligible on elongation too. From the evaluation of the test results including metallographic observation of ring specimens after fracture, it was concluded that segregation of hydrides due to thermal diffusion of hydrogen during irradiation was at least a part responsible to the above effect of hydrogen enhancing embrittlement.

807 Tritium removal and retention device. (to Westinghouse Electric Corp., Pittsburgh, Pa. (USA)). Netherlands Patent 7610454/A/. 21 Sep 1976. Priority date 14 Oct 1975, United States of America (USA). 24p. (In Dutch).

The patent discloses an apparatus comprising a two-layered composite with an internal core of zirconium or zirconium alloy which retains tritium, and an adherent nickel outer layer which acts as a protective and selective window for passage of the tritium. The invention provides a device to remove and store tritium from a gaseous medium as well as a method for manufacturing the device. It specifically provides a device which may be incorporated in the fuel rod of a nuclear reactor to minimize release of tritium to the reactor coolant.

808 Nuclear fuel and fuel element production. Review. Smirnov, Y.V.; Nekrasova, G.A.; Rodin, S.S. No. 10, 10-17(Oct 1975). (In Russian).

56 refs., 6 tables.

The current state of the nuclear fuel and fuel element industry abroad and trends in future development are reviewed. Predictions are that by 1980 we may expect a significant increase in industrial power plants operating with uranium dioxide. A predominant part (>99%) of the fuel and fuel element industry is located in developed capitalistic countries: USA, Federal Republic of Germany, France, Great Britain, Japan, and Canada. More than half the world's production and use of nuclear fuel for LWRs (light water reactors) is in the USA. Some 70 plants in operation for producing fuel and fuel elements can process 9 to 10 thousand tons of uranium fuel (calculated on the basis of uranium) per year and about 30 to 40 tons of plutonium fuel (calculated on the basis of plutonium) per year. In 1990 the consumption of nuclear fuel will probably be 5 to 6 times that in 1973, and will be about 30 to 40 thousand tons (U+Pu) per year. Oxide fuel for LWRs will continue to predominate. In the development of a nuclear fuel production industry there is a very definite trend to concentration of the industry and formation of large industrial complexes and engineering cycles which include all operations from production of initial fuel to manufacture of fuel elements and assemblies.

CONTROL SYSTEMS

809 Interlocking device for the control rod drive of a nuclear reactor. Thorp, A.G.; Thorp, R.S. (to Westinghouse Electric Corp., Pittsburgh, Pa. (USA)). German(FRG) Patent 1,911,057/B/. 10 Feb 1977. 3p. (In German).

4 figs.

An interlock for the control rod drive of a nuclear reactor arranged within a thimble which itself is connected in a pressure-tight manner with the reactor pressure vessel is described, the locking being achieved by gearing of ratchets into a tooth construction of a drive shaft connected with the control rod. The invention is based on the task to design the interlock in such a way that an undesired movement of the reactor control rods on occurrence of leaks in the thimble is safety prevented, i.e. not only in resting position of the control rod, but also if it is being moved and therefore a normal gearing is not provided.

810 Future concepts for process computer techniques in power stations. Dettloff, K. (Siemens A.G., Karlsruhe (Germany, F.R.). Geschaeftsbereich Mess- und Prozesstechnik). **57**: No. 2, 89-95(Feb 1977). (In German).

13 figs.

Process computers have passed through significant stages of development in the areas of hardware, software and standby practice. New computers with a new periphery, as for example, colour viewing equipment, have been developed and the introduction of process computers in power station control technology is advanced. The development of individual components for the new data processing technology in the power station can be regarded as completed.

811 Neutron-absorbing alloy. Portnoi, K.I.; Arabei, L.B.; Griasnow, G.M.; Lewi, L.I.; Lunin, G.L.; Koschuchow, W.M.; Markow, J.M.; Fedotow, M.E. German(FRG) Patent 2,401,342/B/. 4 Nov 1976. 2p. (In German).

A neutron-absorbing alloy is described which may be used for automatic control and protection systems in nuclear reactors. It has good corrosion resistance and a large capture cross section for thermal and intermediate neutrons. It is characterized by the following data: indium 1-20%, samarium 0.5-15%EE, hafnium 5-18%, and nickel 47-93.5%. Preferably: 10% indium, 8% samarium, 13.5% hafnium, 68.5% nickel. From the alloy according to the invention also control rods usable in thermal power reactors may be cast.

812 Position indication for a control rod movable in a nuclear reactor. Jahn, G.; Waldmann, H.; Werner, F.; Wolf, J. (to Siemens A.G., Berlin (Germany, F.R.); Siemens A.G., Muenchen (Germany, F.R.)). German(FRG) Patent 2,242,951/B/. 16 Sep 1976. 3p. (In German).

3 figs.

It is shown how the accuracy of measurement of the control rod position in a nuclear reactor may be improved. The movable control rod is gliding in a tube fastened to the reactor pressure vessel, to which belong two coils whose inductive coupling depends on the position of the control rod, one coil being fed by a sinusoidal alternating voltage and the voltage of the other serving as an indication for the position of the control rod. According to the invention it is provided for the number of windings per unit length of the first and/or of the second coil to be larger at one or both ends of the tube than in the central area. It is of advantage if the second coil feeds into a limit-value alarm for operating a limit switch.

813 Control of a nuclear propulsion plant. Connell, C.W. Jr.; Welch, T.R. (Babcock and Wilcox Co., Lynchburg, Va. (USA). Nuclear Power Generation Div.); Patterson, C.P. (U.S. Maritime Administration, Washington, D.C., USA). pp 193-200 of In Ship operation automation. Pitkin, M.; Roche, J.J.; Williams, T.J. (eds.). Amsterdam, Netherlands; North-Holland (1976).

From 2. ship operation automation symposium; Washington, D.C., USA (30 Aug 1976).

Implementation of a nuclear steam supply system on board a ship as the propulsion plant requires an automatic reactor protection/control/monitoring system which is fully integrated with the propulsion turbines and auxiliaries. The paper describes such a system and its interfaces with the remaining engine room systems.

814 Structure of supporters for reactor control rod drives. Sato, H.; Sasaki, M.; Toyoda, T. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-95594/A/. 19 Feb 1975. 3p. (In Japanese).

Object: To construct the support structure such that water can be loaded in it, thereby reducing both load on the reactor building and radioactive radiation dose factor with respect to the top of the building. Structure: During maintenance the operation of the reactor is stopped and water is loaded from a water supply duct into a space defined by a top duct plate, bottom duct plate, side barrel and control rod drive means sleeve to thereby reduce the radioactive radiation dose factor. During reactor operation, water loaded in the afore-said space is diacharged through an exhaust duct to reduce load on the support means and reactor building.

815 Device for detecting abnormal reactor operation. Shimiya, Y.; Aoki, R. (to Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). Japanese Patent 1976-95596/A/. 19 Feb 1975. 4p. (In Japanese).

Object: To detect by means of a sound detector abnormal sounds produced within the reactor container to thereby promptly detect abnormal equipment vibration or cracks in the piping. Structure: A device for detecting abnormal reactor operation comprising at least one sound detecting element such as a nondirectional microphone provided within a reactor container, whereby flow-out or leakage of a high pressure primary cooling medium from piping and valves within the container or abnormal equipment vibration is detected through detection of whether or not the detection signal level of said detecting element is higher than the value during normal reactor operation.

816 Power monitoring means for boiling water reactor. Kawai, T. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-94095/A/. 17 Feb 1975. 4p. (In Japanese).

Object: To eliminate the effect of noise and increase the response speed. Structure: Noise components obtainable by noise separation filter means from measured values of inlet flow rate, core pressure and other process quantities are coupled to respective transfer function quasi-circuits, whereby the contribution to the noise components of the neutron flux are obtained from the respective noise components. Since by coupling these portions to an adder a neutron noise component can be obtained, they are coupled to a subtractor for subtraction from the measured value of neutron flux, whereby the intended neutron flux signal can be obtained for display.

817 Reactor control rod. Yamagishi, Y.; Watanabe, T.; Imayoshi, S. (to Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). Japanese Patent 1976-94094/A/. 17 Feb 1975. 4p. (In Japanese).

Object: To increase reliability of the control rod drive mechanism at the time of emergency stop while also simplifying the construction and maintenance. Structure: The reactor container is divided into a high pressure chamber and a low pressure chamber, with a first cooling medium passage formed between a control rod guide tube and an absorbent guide inner tube, A throttle is provided in an opening of the top wall of the tube while the upper end of an extension tube is provided with a head adapted to be engaged with a gripper of a control rod drive mechanism. A shoulder is formed at a coupling portion between the absorber outer tube and extension tube, and a second cooling medium path is formed between the outer tube and guide tube. The outer tube has a lower end open toward the bottom of the tube and the outer periphery of the lower end is provided with a throttle having the effect of effectively throttling the flow from the second cooling medium path to thereby produce a pressure difference. A downward pressure is exerted upon the shoulder of the outer tube according to the pressure relation after the cooling medium has flown through the high pressure chamber and absorbent with the control rod in the withdrawn state. At the time of emergency stop the gripper is operated to release the coupling with the head, whereby the control rod is lowered at a high speed due to the effect of gravity and the pressure difference.

818 System for monitoring the shut-down margin of a reactor. Motoda, H. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-92996/A/. 10 Feb 1975. 4p. (In Japanese).

Object: To monitor whether the operation of a reactor can be safely stopped if for some reason a given rod should be incapable of being inserted into a reactor core. Structure: Detection signals representing neutron flux distribution around a specified control rod in the reactor, reactor core flow rate, reactor core outlet temperature and so forth are fed into a performance calculating means for calculating nuclear characteristics of a fuel assembly only in the vicinity of a specified control rod at the time of reactor shut-down. The results of calculation are then fed to a reactor shut-down safety margin evaluating means, whereby the specified control rod is withdrawn from the reactor core while the reactivity of the reactor with all the other control rods inserted in the reactor core is estimated. In this way, the reactor shut-down safety margin with respect to the specified control rod is obtained and indicated by display means.

819 Process for analysing the activity of a radioactive blast. Lecomte, P.; Le Meur, R. (to CEA, 75 - Paris (France)). French Patent 2294455/A/. 13 Dec 1974. 22p. (In French).

A description is given of a process for analysing the activity of a radioactive blast circulated by a fluid in a pipe. The activity of the moving fluid is determined at a point in the pipe. The movement is detected when the activity measured reaches a maximum. The blast is isolated in a part of the pipe forming a measurement chamber and the activity is analysed on the blast so isolated. In order to detect when the activity reaches a maximum, it is measured by determining the count rate by an analog or digital method. The result of this determination is converted into an electric voltage. The voltage figure obtained is memorised. The voltage figure obtained is compared continually with the figure memorised and the moment when the voltage obtained becomes less than the figure stored is determined. To determine the moment when the activity reaches a maximum, the instant when the absolute value of the count rate curve slope with time commences to increase is determined.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 1407, 1408

820 Nuclear power stations and the environment. Facius, H. (Kraftwerk Union A.G., Offenbach (Germany, F.R.)). **23**: No. 3, 65-67(May 1977). (In German).

Nuclear power stations are being given particular attention by the public and in many cases they are presented as the energy generator which threatens special danger to the environment. Although there is no scientific controversy over the fact that the pollution of the environment caused by coal- and oil-fired power stations is far greater than that from nuclear power stations, the negative attitude may be due to the undectable danger produced by radioactive radiation. What is the actual position. The author attempts, on the basis of available operational reports and neutral authorities, to get to the bottom of the questions of environmental pollution by nuclear power stations.

821 Die Wahrheit ueber die Atomkraftwerke. Gefahren fuer Mensch und Wasser. (Truth about nuclear power plants. Hazards for man and water). Hoell, K. Muenchen, Germany, F.R.; Pfriemer (1977). 175p. (In German).

This book discusses, in a popular way: risks of nuclear facilities, population exposure, accidents in existing nuclear power plants, increasing contamination of the environment, thermal pollution of waters, emergency measures. Most of the information is not new and not very informative to interested citizens, with the exception of the special fields of the author - water hygiene and related fields.

SITING

REFER ALSO TO CITATION(S) 979, 1410

822 Nuclear sites of the next decade. Lebreton, J.C. (Electricite de France, 75 - Paris. Dept. Etudes Generales Programmes-Sites Environnement). **27**: No. 287, 474-483(Oct 1976). (In French).

Development and perspectives of nuclear siting procedures in France are analyzed. Technical and socio-political aspects which characterize this problem for the period 1976-1986 are described and the sites required by the French nuclear program are listed.

823 Nuclear power development and public acceptance. Yoda, S.; Yamada, A. (Tokyo Electric Power Co. Inc. (Japan)). **22**: No. 10, 70-74(Oct 1976). (In Japanese).

The public acceptance aimed at realizing the development of nuclear energy of 49,000,000 kW in 1985 in accordance with the basic policy of the combined energy measures in Japan determined by the cabinet meeting in December 1975 is discussed, and the three principles, namely democracy, independence, and disclosures under Article 2 of the Atomic Energy Act, are reviewed. Stronger friction may occur owing to the following characteristics of nuclear power development: it is comprehensive but apt to be sectional, too large scale, very long term, military secrecy, and international relations. In addition, there are the sensibility to radioactivity and illogical refusal in Japan. As to the democracy, the participation of the people in the development of nuclear power has not so far been considered. For example, the holding of public hearings has not been a legal obligation, but only a by-law of Atomic Energy Commission. As to the independence, serious troubles have been experienced because of the complete dependence on U.S. techniques. As to the disclosure, the opening to the public of the commercial secrecy attached to the application for the approval of reactor installations is apt to be much disputed. In conclusion, it is believed that there is no other way than the exertion of straight effort under the three principles, so that the formation of public acceptance will be accomplished. (Iwakiri, K.).

824 Countermeasures for siting and environment of nuclear power plant. Nuclear power as the model industry for environment protection. Kawakami, K. (Kanagawa Univ., Yokohama (Japan)). pp 65-89 of In Genshiryoku hatsuden kaihatsu suishinjo no shomondai. Tokyo, Japan; Fuji International (1976). (In Japanese)

Though the requests to urge the construction of nuclear power plants increased since the oil crisis, it is clear that it is necessary to take some countermeasures without delay at present because the location problems are in deadlock. Drastic change of the way of thinking should be made first if the social and political extensions of the problem are considered. It must require the persevering effort based on long-range outlook. Accordingly, emphasis is put on the introduction of the environmental administration in U.S. which seems to have many respects to be referred to in the following description. Then National Environmental Policy Act and the permission and approval procedures for nuclear power stations in U.S.

are described, and the details of environmental disputes are listed. It reveals the discrepancy of the actual circumstances in Japan and the United States, and that the important portion of the U.S. experience and concept is not learned by Japanese. The Government lacks the recognition that the public acceptance of safety is not obtained till the report of safety investigation and environmental assessment by the governmental organizations are entrusted to people's judgement. That is, the procedures to win the public acceptance are omitted in Japan. The thoroughness of environmental protection is first of all necessary for achieving the target of nuclear power development. Since it seems to be nothing but the countermeasures for the public acceptance of nuclear power generation to cope with "60 mens' testimony", the main points of the "Sixty mens' testimony" in Fukushima public hearing are cited at the end, which is supposed to include almost all opposite opinions.

825 Way of nuclear power plant siting in future. Miki, S. (Japan Industrial Location Center, Tokyo). pp 281-303 of In Genshiryoku hatsuden kaihatsu suishinjo no shomondai. Tokyo, Japan; Fuji International (1976). (In Japanese)

As the scale in siting power sources becomes larger and the use of nuclear fuel increases, more problems arise. The siting of power sources is encountering great difficulties due to the amplification of anxiety of inhabitants regarding siting nuclear and thermal power plants of large capacity, and it resulted in the significant drop of power reserve rate. Therefore, in order to secure the sites, it is necessary to consider the construction of power plants which can contribute to the community, endeavoring to recover the reliance lost to date. Two case-studies of the power source-siting model are described from the more wide-area, longer term viewpoint: the one is the regional development model, in which the overall energy utilization in a region around a nuclear power complex is contemplated, and another is the concrete case study on the siting of a thermal power plant associated with the formation of a local core city. In the case study regarding the formation of a local core city, the problems of the siting of a new thermal power plant in the middle Kitakami region, Iwate Prefecture, are taken up. In the study on a nuclear power plant, investigation was performed for each subsystem by taking environment preservation in consideration, but technical and economical studies are not sufficient. Also the presence of complex pollution as a whole system, the evaluation of energy utility supply to the inhabitants, and the procedures and management of the development must be investigated.

826 Actual status and future outlook of Fukushima prefecture for accepting power plants. Origasa, Y. (Fukushima Prefecture (Japan)). pp 171-203 of In Genshiryoku hatsuden kaihatsu suishinjo no shomondai. Tokyo, Japan; Fuji International (1976). (In Japanese)

The fundamental attitude of Fukushima prefecture to wrestle with nuclear power generation is explained after having described the details of inviting nuclear power plants. The prefecture intends to promote the nuclear power development in cooperation with the government, related cities, towns and villages, and electric power companies, and to develop the Futaba area, the coastal region of Pacific Ocean belonging to the low-developed area, by turning it to the base of nuclear power generation. The prefecture has improved its organization to strengthen nuclear power administration. The prefecture also has concluded the convention on the security for nuclear power plants with Tokyo Electric Power Co. It takes care of the propagation of knowledge concerning nuclear energy and is endeavoring to provide accurate and impartial information. The problem in promoting nuclear power generation is to obtain the consensus of inhabitants for the location of nuclear power plants. Problems on warm water discharge, employment, and of enterprises in the area are to be considered on the basis of the coexistence and coprosperity of local community and power stations. The prefecture needs more powerful public relations on nuclear power, security, and fulfillment of the policy for environmental preservation, and enforcement of environmental assessment, by the government. It also demands that the enterprises complete the system that they can have their own function of the environment control.

827 Siting of nuclear power plants and administration in cities, towns and villages. Yabe, C. (Fukui Prefecture (Japan)). pp 204-245 of In Genshiryoku hatsuden kaihatsu suishinjo no shomondai. Tokyo, Japan; Fuji International (1976). (In Japanese)

For the siting problems, there are many explanations and documents from the side to construct nuclear power plants, but few which make assertions from the side of accepting the plants. However, present difficulties in the siting problems of nuclear power plants cannot be solved if the assertion of the accepting side is neglected. The details from the start of the siting to now in Tsuruga city are described. It is tried to explain the situation with the documents expressing opinions, demands and petitions, and replies exchanged between Tsuruga city and the government, Fukui Prefecture, and the related power companies, and the related laws. The details include the failures and accidents of nuclear plants reported to date. The reasons why the mayors or headmen of towns or villages want to invite the nuclear power plants are that the development of their region can be expected, and favorable influence results to the regional economy, and further they can cooperate with the national policy. However, opposition movements are the most embarrassing affairs for them, and it is due to the condition that they cannot give the satisfactory answer to the opposing people so far. They must depend solely on the responsibility of the government for safety. On the organizations of cities, towns and villages accepting nuclear power plants and the influence on local community, detailed reports are presented using various documents on preparation, antidisaster plan, radiation monitoring organization, movement of population, the effects regarding tax system and finance, influence on the life of inhabitants and others.

828 Act No 393 of 2 August 1975 on requirements for the siting of nuclear electricity generating plants and for the production and use of electrical power. No. 224, 5875-5879(23 Aug 1975). (In Italian).

Before publication of Act No 393, the construction of nuclear power plants had been subject only to the provisions of Presidential Decree No 185 of 13 February 1964 on nuclear safety and radiation protection, since Basic Act No 1860 of 31 December 1962 provides that licensing of such plants is outside its ambit. The Act lays down a special administrative procedure for siting nuclear power plants, involving the regional authorities as well as the Interministerial Committee for Economic Planning (CIPE), the Ente Nazionale per l'Energia Elettrica (ENEL) and the National Committee for Nuclear Energy (CNEN). The provisions of the Act, while providing a step by step prior consultation of the Communes selected for siting nuclear plants also lay down that if no reply is forthcoming at regional or local level within the given time-limits, the decision is taken in any event by the higher national authority, namely the CIPE.

RADIOACTIVE EFFLUENTS

829 Radioactivity releases. Chapter 12. Leonard, J.H. pp 343-370 of In Elements of nuclear reactor design. Weisman, J. (ed.) (Cincinnati Univ., Ohio (USA). Dept. of Chemical and Nuclear Engineering). Amsterdam, Netherlands; Elsevier (1977).

Radioactivity is produced directly in the fission process (fission products) and by neutrons, born in the fission process, which interact with reactor materials to create additional radioactive species (activation products). Confinement and control of these sources of radioactivity are necessary to assure that operating personnel as well as the general public are not adversely affected. Evaluation of safety aspects generally fall into two categories. Radioactivity releases associated with normal reactor-operating conditions is one of these categories. Routine activity release must always be kept at extremely low levels relative to naturally-occurring radioactivity levels in the environment for a reactor to be deemed safe and acceptable. The other category considered is potential activity releases under accident conditions which are conceivable although very unlikely. Under such conditions, the amount of radioactivity potentially available for release is orders of magnitude larger than under routine conditions. Consequently, safety analyses must be conducted in considerable detail, and appropriate features must be incorporated in the reactor design to assure that adequate safety margins will be maintained under all postulated accident conditions. Methods for determining the amount of radioactive substances present in a reactor are examined. This is followed by consideration of the possible pathways by which these materials might enter the environment.

RESEARCH, TEST, AND EXPERIMENTAL REACTORS

REFER ALSO TO CITATION(S) 740, 844

830 (CONF-770401—29) **Summary of the ORNL shield design supporting analysis for the FFTF.** Engle, W.W. Jr.; Mynatt, F.R.; Emmett, M.B. 1977. Contract W-7405-ENG-26. 9p. Dep. NTIS, PC A02/MF A01.

From 5. international conference on reactor shielding; Knoxville, Tennessee, United States of America (USA) (18 Apr 1977).

From 1969 through early 1976, Oak Ridge National Laboratory was requested by the Westinghouse Advanced Reactors Division (WARD) to analyze various shields WARD designed for the Fast Flux Test Facility (FFTF). To develop the proper methodology for such a large and complex system, it was necessary to improve the basic cross-section data sets for sodium and iron and to devise calculational techniques which would allow some regions to be treated in detail and would also allow the analyses to be carried out in steps that could be coupled to each other. These requirements necessitated the performance of two types of experiments: measurements of radiation transport through bulk samples (simple geometry) of important FFTF materials; and measurements of radiation trans-

port through mock-ups of specific geometric regions of the FFTF. The successful analyses of these experiments allowed the application of the derived data sets and various combinations and adaptations of the DOT discrete ordinates and MORSE Monte Carlo transport codes to the FFTF system itself. The first series of calculations for the full system revealed that a cavity surrounding the reactor vessel provided a pathway for neutrons to stream up to the head compartment. Also, fissions in fuel elements stored in the outer region of the reactor vessel were found to contribute significantly to the cavity streaming. As a result, the major ORNL effort was expended on analyzing various designs of a concrete shield to be added in the upper region of the reactor cavity. With the inclusion of the shield and modifications to the reactor vessel support system, the dose rates above the closure head were reduced by a factor of approximaterly 10^4.

831 (HEDL-TME—76-45) **FFTF development testing technical progress report, January, February, March 1976.** Berg, J.D.; Bliss, R.J.; Duncan, H.C.; Worth, G.A.; Duckett, A.J. Jul 1977. Contract EY-76-C-14-2170. 24p. .

Information is presented concerning refueling and plant equipment testing, mechanical equipment testing, reactor components testing, and control and data systems.

832 (HEDL-TME—77-43) **Operating experiences and analysis of FFTF and HTSF cold trap economizers.** Hassberger, J.A. Jun 1977. Contract EY-76-C-14-2170. 73p. .

Operating experience with the Type-I and Type-III cold traps in the High-Temperature Sodium Facility demonstrated that the sodium regnerative heat exchangers (economizers) did not meet design specifications. Initial operating data from the Type-I economizer pointed to a major problem in tube-side flow maldistribution. Hydraulic tests on the Type-III economizer verified that the severity of flow maldistribution could be minimized through the use of tube orifices. Subsequent in-sodium heat transfer tests, however, showed that other significant problems existed, such as shell-side flow maldistribution and annulus free convection. The performances of the various economizers, both as-built and modified or projected, are described. Primary emphasis was placed on correcting tube-side deficiencies. Alternate mechanisms contributing to degraded performance are also discussed.

833 (ORNL/TM—5977) **High flux isotope reactor. Quarterly report, January, February, and March of 1977.** Corbett, B.L.; McCord, R.V.; Poteet, K.H. Jun 1977. Contract W-7405-ENG-26. 21p. Dep. NTIS, PC A02/MF A01.

Routine reactor operation with four end-of-cycle shutdowns this quarter resulted in an on-stream time of 94.5 percent. The semiannual reactor-component inspection was completed, and the control plates were changed.

834 (ORNL/TM—6010) **Bulk shielding facility quarterly report, October, November, and December 1976.** Hurt, S.S. III; Lance, E.D.; Thomas, J.R. Aug 1977. Contract W-7405-ENG-26. 35p. Dep. NTIS, PC A04/MF A01.

The BSR operated at an average power level of 1,836 kw for 78.01 percent of the time during October, November, and December. Water-quality control in both the reactor primary and secondary cooling systems was satisfactory. The PCA was used in training programs and was operated on two occasions when the University of Kentucky students actively participated in training laboratories.

835 **Fission spectrum averaged cross sections of some threshold reactions measured with fast reactor 'YAYOI'.** Kobayashi, K.; Kimura, I. (Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst.); Nakazawa, M.; Akiyama, M. **13**: No. 10, 531-540(Oct 1976).

Fission spectrum averaged cross sections of twenty one threshold reactions were measured in the core center of YAYOI which was a fast neutron source reactor. Fast neutron spectrum in the core was experimentally determined by using a set of activation foils and micro-fission counters, prior to the cross section measurements. It was found that the shape of the fast neutron spectrum was approximately the same as that of fission neutrons above about 2 MeV. This fact was also supported by theoretical calculation. Since this neutron field has scarce thermal and epithermal neutrons, measurement of nuclei produced by threshold reactions is not affected by (n,γ) reactions which are induced by thermal and epithermal neutrons. Moreover, considerably high fast neutron flux (about $5x10^{11}$ n/cm^2.sec) enables to measure cross sections of small values. The results in general agreed with the previous values obtained in a reactor core or with a fission plate within an experimental error, while they were systematically smaller by about 10% than those recommended by Fabry. The measured values are also compared with the results calculated by Pearlstein based on a statistical model.

836 (NP-tr—1976) **Reactivity Accident Laboratory and NSRR Operation Section quarterly progress report on the NSRR experiments (1) combined, October 1975—March 1976.** Ishikawa, M.; Tomii, K. 28 Jun 1976. Translation of JAERI-M—6635. 100p. Regulatory Commission, Washington, DC.

In-pile experiments related to nuclear fuel behavior during reactivity-initiated accidents were started in the Nuclear Safety Research Reactor (N.S.R.R.), a thermal pulsed reactor, in October 1975, subsequent to the first criticality in June 1975. A total of 29 tests were carried out during the two quarters from October 1975 to March 1976. As result, PWR type fuel rods (standard test fuel rods) failed with circumferential cracks penetrating the cladding tube at energy deposition of 232 cal/g . UO_2. Also, in the waterlogged fuel test (JPDR-II fuel rods plus water), a fuel rod cracked at energy deposition of 141 cal/g . UO_2 due to the increase in internal pressure. Described are the results of the tests, test procedures, and present status of analytical works.

PROPULSION REACTORS

REFER ALSO TO CITATION(S) 983

NUCLEAR SHIPS LICENSING AND REGULATION

REFER ALSO TO CITATION(S) 983

REACTOR SAFETY

REFER ALSO TO CITATION(S) 708

837 (AD-A—039908) **Evaluation of GCFR PCRV containment capability. Final report Jul 1974—Jun 1976.** Connor, J.G. Jr; Giltrud, M.E. 15 Apr 1977. 85p. (NSWC/WOL/TR—77-42). NTIS PC A05/MF A01.

An analytical evaluation of the containment capability of the Prestressed Concrete Reactor Vessel for the Gas Cooled Fast Breeder Reactor has been conducted. Displacement and stress predictions were made from NASTRAN finite element calculations which were consistent with static hydraulic loading tests of 1/20 scale PCRV models. This favorable comparison strengthens confidence in the results of NASTRAN calculations for static and transient loading of the full scale GCFR-PCRV. The NASTRAN results imply that a Core Disassembly Accident of 4000 MWsec thermal energy release should be contained by the PCRV with only moderate cracking at the inside of the lower haunch. This value should be substantiated by experiment before further analysis is performed.

838 (ANL—77-4) **Occurrence of critical heat flux during blowdown with flow reversal.** Leung, J.C.M. Jan 1977. Contract W-31-109-ENG-38. 124p. Dep. NTIS, PC A06/MF A01.

A small-scale experiment using Freon-11 at 130°F (54.4°C) and 65 psia (0.45 MPa) in a well-instrumented, transparent annular test section was used to study the occurrence of critical heat flux (CHF) during blowdown with flow reversal. The inner stainless steel tube of the annulus was uniformly heated over its 61-cm length. Inlet and exit void fractions were measured by a capacitance technique. Flow-regime transition was observed with high-speed photography. A 1-hr contact time between Freon-11 and nitrogen at 130°F (54.4°C) and 60 psig (0.517 MPa) was found to greatly affect the steady-state subcooled-boiling initial conditions. Delay in bubble growth was observed in adiabatic blowdown runs. This was caused by the conditions of thermodynamic nonequilibrium required for the unstable bubble growth. For the diabatic runs, equilibrium was more closely approached in the test section during the early phase of blowdown.

839 (BAW—10060) **Reactor internals design/analysis for normal, upset, and faulted conditions.** Burke, F.R. Jun 1977. vp. and Wilcox, Lynchburg, VA.

The analytical procedures used by Babcock and Wilcox to demonstrate the structural integrity of the 205-FA reactor internals are described. Analytical results are presented and compared to ASME Code allowable limits for Normal, Upset, and Faulted conditions. The particular faulted condition considered is a simultaneous loss-of-coolant accident and safe shutdown earthquake. The operating basis earthquake is addressed as an Upset condition.

840 (BNL-NUREG—50683) **Reactor safety research programs. Quarterly progress report, April 1—June 30, 1977.** Romano, A.J. (comp.). Aug 1977. Contract EY-76-C-02-0016. 201p. Dep. NTIS, PC A10/MF A01.

The projects reported are the following: gas reactor safety evaluation, THOR code development, SSC code development, LMFBR and LWR safety experiments, fast reactor safety code validation, technical coordination of structural integrity and fast reactor safety reliability assessment.

841 (CONF-770807—24) **Heavy-Section Steel Technology Program intermediate-scale pressure vessel tests.** Bryan, R.H.; Merkle, J.G.; Smith, G.C.; Whitman, G.D. 1977. Contract W-7405-ENG-26. 15p. Dep. NTIS, PC A02/MF A01.

From 4. international conference on structural mechanics in reactor technology; San Francisco, California, United States of America (USA) (15 Aug 1977).

The tests of intermediate-size vessels with sharp flaws permitted the comparison of experimentally observed behavior with analytical predictions of the behavior of flawed pressure vessels. Fracture strains estimated by linear elastic fracture mechanics (LEFM) were accurate in the cases in which the flaws resided in regions of high transverse restraint and the fracture toughness was sufficiently low for unstable fracture to occur prior to yielding through the vessel wall. When both of these conditions were not present, unstable fracture did occur, always preceded by stable crack growth; and the cylinders with flaws initially less than halfway through the wall attained gross yield prior to burst. Predictions of failure pressure of the vessels with flawed nozzles, based upon LEFM estimates of failure strain, were very conservative. LEFM calculations of critical load were based upon small-specimen fracture toughness test data. Whenever gross yielding preceded failure, the actual strains achieved were considerably greater than the estimated strains at failure based on LEFM. In such cases the strength of the vessel may be no longer dependent upon plane-strain fracture toughness but upon the capacity of the cracked section to carry the imposed load stably in the plastic range. Stable crack growth, which has not been predictable quantitatively, is an important factor in elastic-plastic analysis of strength. The ability of the flawed vessels to attain gross yield in unflawed sections has important qualitative implications on pressure vessel safety margins. The gross yield condition occurs in light-water-reactor pressure vessels at about 2 x design pressure. The intermediate vessel tests that demonstrated a capacity for exceeding this load confirm that the presumed margin of safety is not diminished by the presence of flaws of substantial size, provided that material properties are adequate.

842 (EPRI-NP—483) **Additional methodology development for statistical evaluation of reactor safety analyses.** Marshall, J.A.; Shore, R.W.; Chay, S.C.; Mazumdar, M. Mar 1977. 108p. Dep. NTIS, PC A06/MF A01.

The project described is motivated by the desire for methods to quantify uncertainties and to identify conservatisms in nuclear power plant safety analysis. The report examines statistical methods useful for assessing the probability distribution of output response from complex nuclear computer codes, considers sensitivity analysis and several other topics, and also sets the path for using the developed methods for realistic assessment of the design basis accident.

843 (GEAP—10207-39) **Reactor primary coolant system pipe rupture study. Progress report No. 39, January—March 1977.** May 1977. Contract EY-76-C-03-0893. 38p. Dep. NTIS, PC A03/MF A01.

The pipe rupture study is designed to extend the understanding of failure-causing mechanisms and to provide improved capability for evaluating reactor piping systems to minimize the probability of failures. Following a detailed review to determine the effort most needed to improve nuclear system piping, analytical and experimental efforts were started in 1965. The progress report summarizes the recent accomplishments of a broad program in (a) basic fatigue crack growth rate studies focused on LWR primary piping materials in a simulated BWR primary coolant environment, and (b) studies directed at quantifying weld sensitization in Type-304 stainless steel.

844 (HEDL-TME—77-25) **Improved subassembly grouping for multi-channel top HCDA safety analysis.** Wilburn, N.P. Jul 1977. Contract EY-76-C-14-2170. 50p. .

The behavior of two FTR cores, the BOC-4 and EOC-4, is investigated for TOP HCDA's using the 100-channel MELT-IIIA code. Each of the 76-driver subassemblies is assigned a channel. Using the results from the 76-channel runs, a more effective method to group subassemblies into a lesser number of channels is developed. The results of a 7-channel grouping using this method are compared to results from a former method and the 76-channel runs.

845 (NUREG—0262) **Study of dryout heat fluxes in beds of inductively heated particles.** Dhir, V.K.; Catton, I. Feb 1977. 92p. NTIS $5.00.

Experimental observations of the dryout heat fluxes for inductively heated particulate beds have been made. The data were obtained when steel and lead particles in the size distribution 295-787 microns were placed in a 4.7 cm diameter pyrex glass jar and inductively heated by passing radio frequency current through a 13.3 cm diameter multi-turn work coil encircling the jar. Distilled water, methanol and acetone were used as coolants in the experiments, while the bed height was varied from 1.0 to 8.9 cm. Different mechanisms for the dryout in deep and shallow beds have been identified. Dryout in shallow beds is believed to occur when the vapor velocity in the gas jets exceeds a certain critical velocity at which choking of the vapor occurs, leading to obstruction in the flow of the liquid toward the bed. However, deep beds dry out when gravitational force can no longer maintain a downward coolant flow rate necessary to dissipate the heat generated in the bed. The heat flux data of the investigation and that from two previous investigations made at Argonne Laboratory and at UCLA have been correlated with semi-theoretical correlations based on the proposed hydrodynamic models. The deep and shallow bed correlations are used to predict the bed height at which transition from deep to shallow bed would occur. An application of the study has been made to determine the maximum coolable depths of the core debris as a function of the particle size, bed porosity and decay heat.

846 (ORNL/NUREG/NSIC—137) **Annotated bibliography of safety-related occurrences in boiling-water nuclear power plants as reported in 1976.** Scott, R.L.; Gallaher, R.B. 2 Aug 1977. Contract W-7405-ENG-26. 429p. Dep. NTIS, PC A19/MF A01.

This bibliography contains 100-word abstracts of reports to the U.S. Nuclear Regulatory Commission concerning operational events that occurred at boiling-water reactor nuclear power plants in 1976. The report includes 1,253 abstracts that describe incidents, failures, and design or construction deficiencies that were experienced at the facilities. They are arranged alphabetically by reactor name and then chronologically for each reactor. Key-word and permuted-title indexes are provided to facilitate location of the subjects of interest, and tables that summarize the information contained in the bibliography are provided. The information listed in the tables includes instrument failures, equipment failures, system failures, causes of failures, deficiencies noted, and the time of occurrence (i.e., during refueling, operation, testing, or construction). Three of the unique events that occurred during the year are reviewed in detail.

847 (ORNL/NUREG/NSIC—138) **Annotated bibliography of safety-related occurrences in pressurized-water nuclear power plants as reported in 1976.** Scott, R.L.; Gallaher, R.B. 1 Aug 1977. Contract W-7405-ENG-26. 448p. Dep. NTIS, PC A15/MF A01.

The bibliography contains 100-word abstracts of reports to the U.S. Nuclear Regulatory Commission concerning operational events that occurred at pressurized-water reactor nuclear power plants in 1976. Included are 1264 abstracts that describe incidents, failures, and design construction deficiencies experienced at the facilities. They are arranged alphabetically by reactor name and then chronologically for each reactor. Key-word and permuted-title indexes are provided to facilitate location of the subjects of interest, and tables summarizing the information contained in the bibliography are presented. The information listed in the tables includes instrument failures, equipment failures, system failures, causes of failures, deficiencies noted, and the time of occurrence (i.e., during refueling, operation, testing, or construction). A few of the unique events that occurred during the year are reviewed in detail.

848 (ORNL/NUREG/TM—133) **Noise diagnostics for safety assessment quarterly progress report, April—June 1977.** Kryter, R.C. 21 Jul 1977. Contract W-7405-ENG-26. 13p. Dep. NTIS, PC A02/MF A01.

The information gathering tours of vendors and utility users of loose-parts monitoring systems are nearly complete. Conclusions, recommendations, and proposed scope for further investigations are presented in the report.

849 (ORNL/TM—5940) **LMFBR safety and core systems programs. Progress report, January—March 1977.** Fontana, M.H.; Wantland, J.L. 25 Jul 1977. Contract W-7405-ENG-26. 94p. .

Topics discussed are program coordination; THORS analysis and data evaluation; detection methods development; THORS facility operation; materials for fuel pin simulation; the sodium boiling test facility; neutronics analysis of a disrupted core; central computerized data base for LMFBR safety codes; model evaluation of LMFBR reactivity releases; LMFBR reliability data analysis center; and environmental assessment of advanced LMFBR fuels.

850 (PB—267376) **Natural convection in horizontal fluid layers.** Suo-Antilla, A.J.; Catton, I.; Kastenberg, W.E. Jun 1977. Contract AT(49-24)-0246. 163p. NTIS PC A08/MF A01.

This report represents one aspect of the research program 'Safety Considerations of Commercial Liquid Metal Fast Breeder Reactors.' The research program is divided into the following tasks; (a) transient analysis of fuel elements, (b) accident analysis, (c) post accident heat removal, (d) fuel-coolant interactions and (e) thermodynamic effects. The subject matter of this dissertation is concerned with thermal convection in horizontal fluid layers. The experimental work includes developing and using a thermal convection cell to obtain measurements of the heat flux and turbulent core temperature of a horizontal layer of fluid heated internally and subject to both stabilizing and destabilizing temperature differences.

851 (PB—267576) **Two-phase interactions in countercurrent flow studies of the flooding mechanism. Progress report 1 Nov 1975—30 Sep 1976.** Dukler, A.E.; Smith, L. Jun 1977. Contract AT(49-24)-0194. 58p. NTIS PC A04/MF A01.

During a loss of coolant accident in a pressurized water reactor countercurrent flow, flooding and upflow are all expected to take place. Predicting the transition from counter to upflow requires a reliable model for the flooding process. The first phase of a study is reported here which has the objective of evolving the mechanism for the flow reversal process and of developing sound productive models. This report includes a description of the experimental test loop constructed and the experimental measurements made during the first eleven months of the project. Measurements were made of liquid flowing downward as a film as well as upflow in the film entrained droplets as the system was carried through flow reversal. Time variation of pressure and pressure gradients were measured at four stations along the axis. The measurements demonstrated that the onset of flooding was associated with the onset of entrainment and that wave closure and blocking did not occur. Two types of flooding were observed. When entrainment takes place at the point of liquid entry, then flooding is characterized by a slugging or churning. When entrainment initiates well below the entry, then flow reversal occurs by droplet transport above the feed. Criteria for the existence of these two types of flooding are proposed.

852 (PB—267584) **Suppression pool dynamics. Quarterly progress report 1 Jul 1976—30 Sep 1976.** Catton, I.; Chan, C.K.; Dhir, V.K.; Liu, C.Y. May 1977. Contract AT(48-24)-342. 82p. NTIS PC A05/MF A01.

Transient air-water tests were performed as part of the laboratory scale experiments project to investigate hydraulic response in a BWR Pressure Suppression Containment at the onset of a LOCA. These tests were performed in a cylindrical plexiglass test chamber. Air was injected downward through pipes of different diameters placed in the middle of the test chamber containing water at room temperature. Tests were performed to investigate the effects of submergence depth and dry well pressure on the vent clearing phenomena. Data were also obtained for the pool swell height under the influence of a steady submerged air flow stream, although it is directly not applicable to the BWR LOCA condition.

853 (PB—267585) **Suppression pool dynamics. Quarterly progress report 1 Oct 1976—31 Dec 1976.** Catton, I.; Chan, C.K.; Chiou, H.H.; Dhir, V.K.; Lee, C.K.B. May 1977. Contract AT(48-24)-342. 76p. NTIS PC A05/MF A01.

This report presents the results of transient air-water tests conducted between October 1 to December 31, 1976, to investigate basic hydrodynamical phenomena that can be experienced in a BWR Pressure Suppression Pool at the onset of a Loss of Coolant Accident. Based on the observation of the Taylor instability the scaling of vent clearing phenomena was reconsidered. The governing similitude parameters are found to be the Froude number gL/(U sup 2), the Euler number (P sub c)/(rho sub c) and the Weber number (rho sub c) (U sup 2)/sigma.

854 (TREE-NUREG—1084) **Experiment data report for LOFT nonnuclear Test L1-4.** Batt, D.L. Jul 1977. Contract EY-76-C-07-1570. 231p. Dep. NTIS, PC A09/MF A01.

Test L1-4 was the fourth in a series of five nonnuclear isothermal blowdown tests conducted by the Loss of Fluid Test (LOFT) Program. Test L1-4 was the first Nuclear Regulatory Commission standard problem (International Problem No. 5 and U.S. Problem No. 7) experiment conducted at LOFT. Data from this test will be compared with predictions generated by the standard problem participants. For this test the LOFT Facility was configured to simulate a loss-of-coolant accident in a large pressurized water reactor resulting from a 200% double-ended offset shear break in a cold leg of the primary coolant system. A hydraulic core simulator assembly was installed in place of the nuclear core. The initial conditions in the primary coolant system intact loop were temperature at 279°C, gauge pressure at 15.65 MPa, and intact loop flow at 268.4 kg/s. During system depressurization into a simulated containment, emergency core cooling water was injected into the primary coolant system cold leg to provide data on the effects of emergency core cooling on system thermalhydraulic response.

855 (TREE-NUREG—1118) **Evaluation of the effects of break nozzle configuration in the Semiscale Mod-1 system.** Hanson, R.G. Aug 1977. Contract EY-76-C-07-1570. 39p. Dep. NTIS, PC A03/MF A01.

The Semiscale Mod-1 Program has utilized two different break nozzle configurations in the test system. An evaluation has been made to determine the effect these break nozzle configurations have on system thermal-hydraulic response during a 200 percent double-ended cold leg break loss-of-coolant accident simulation. The first nozzle was a convergent-divergent nozzle (Henry nozzle) and the second, an elongated constant area throat nozzle. Analysis is confined primarily to system response phenomena observed to be affected by the nozzle configuration and concentrates on the fluid response at the break and the resulting core behavior during subcooled and saturated blowdown. The evaluation shows that considerable difference in system response occurs as a result of the difference in break nozzle configuration. The elongated throat nozzle was scaled from the Loss-of-Fluid Test (LOFT) nozzle geometry and since the LOFT counterpart tests were designed to provide results for the LOFT Program, the elongated throat nozzle was used in the subsequent LOFT counterpart tests.

856 **Nuclear power and public opinion. 1**: No. 7, 228-232(Jul 1977). (In Dutch).

The speeches by Bethe and Alfven, delivered at the 1977 Conference in Salzburg, and the report of the World Council of Churches are surveyed, as well as the nuclear controversy and the state-of-the-art reports from various countries on public information and public acceptance of nuclear energy provision.

857 **Plutonium - should we or shouldn't we.** Rippon, S. **23**: No. 7, 552-555(Jul 1977).

The benefits offered to mankind by the production and use of plutonium and the risks to present and future generations of exploiting, or not exploiting, these potential benefits are discussed. The spread of weapons and the possibility of terrorist groups making crude explosive devices are the latest fears to be promoted by the opponents of nuclear energy. The need and the extent of possible security measures are considered.

858 **How UK experts assessed the integrity of PWR pressure vessels.** Collier, J.G.; Marshall, W. (UKAEA). **22**: No. 259, 41-45(Jul 1977).

The methodology used by the team set up under Dr Walter Marshall, to make a technical assessment of the integrity of large PWR pressure vessels is described. The detailed considerations were related to examination of the Westinghouse 4-loop vessel. The general approach was to examine certain topics including design, materials fabrication, materials, fabrication, testing, inspection, organisation and operation. The work of the Study Group is illustrated by discussion of specific examples in the following fields: materials properties, especially fracture toughness; critical crack size; and fatigue crack growth. The results of a questionnaire and survey to determine the efficiency of in-service inspection by ultrasonics are presented. From a probabilistic failure model it was possible to establish the relative factors influencing integrity of a vessel both at the start and near the end of its life. The report concludes with a number of recommendations covering the various topics examined.

859 **How safety assessments for PWR main coolant system components developed in France.** Devaux, J.C. (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 92 - Courbevoie (France)). **22**: No. 259, 45-48(Jul 1977).

Developments in France for the safety assessment of components for PWR type reactors are described. In accordance with US regulations stress analysis reports are needed and the work involved in producing these is discussed. At the same time new computer developments allowed the setting up of finite element calculation methods. The progress of stress analysis techniques is illustrated for nozzles, vessel closure heads, steam generator bottom heads, and refinements for pressurizer nozzles. Finally, current philosophy is briefly summarised.

860 **Safety margins of the containments of nuclear power plants.** Kanzleiter, T.F. (Battelle-Institut e.V., Frankfurt am Main (Germany, F.R.)). **77**: No. 13, 443-446(Jul 1977). (In German). 6 figs.; 2 refs.

The safety design of the containment of pressurized water reactors using presently accepted computing methods contains substantial safety margins. This was found by experiments performed at Battelle-Frankfurt, in which a complete rupture of a primary coolant pipe was simulated in a model containment (12 m diameter) as the design basis accident. A comparison of the experimental results with the results of model computations as used for the design of nuclear power plants always showed that the model computationssubstantially overestimate the stresses actually measured in the experiments. Thus the safety margins in the design methods for nuclear power plants were demonstrated.

861 **Twenty years of nuclear energy in the Federal Republic. 21**: No. 6, 349(Jun 1977). (In German).

In 1957, German industry turned its attention to the use of nuclear energy on a large scale. In their advisory function the heads of R and D in large German companies and some university professors created the basis for the first German nuclear program. A review of all the atomic power stations that have been erected or projected in West Germany is appended to this report.

862 **Publication concerning the draft of a safety guide for nuclear power plants by the International Atomic Energy Agency dated 16th June 1977. 29**: No. 118, 1(Jun 1977). (In German).

The possibility to propose amendments before the BMI makes a final statement on behalf of the FRG is discussed.

863 Fuel rod microstructural changes associated with Post-DNB operation during power-cooling-mismatch (PCM) conditions: the PCM-2A test. Seiffert, S.L.; Martinson, Z.R.; Hobbins, R.R. (EG and G Idaho, Inc., Idaho Falls, ID). **26**: 212-213(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

864 LOCA capability for utility applications. Husain, A. (Yankee Atomic Electric Co., Westboro, MA); Agee, L.J. **26**: 217-218(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

865 Development of utility non-LOCA safety analysis methods. Harris, R.T. (Northeast Utilities Service Co., Hartford) Breen, R.; Buckman, F.W.; Crimmins, T.M. Jr. **26**: 218-219(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

866 Explicit iterative technique for FX2. Daly, T.A.; Abramson, P.B. (Argonne National Lab., IL). **26**: 228-229(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

867 Benchmark specifications and solutions: two fast reactor safety-related slowing-down problems. Prael, R.E.; Toppel, B.J.; Reynolds, B.G. (Argonne National Lab., IL). **26**: 233-234(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

868 Analysis of transient fluid-structure problems using an advanced Eulerian method. Wang, C.Y. (Argonne National Lab., IL). **26**: 239-241(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

869 Simulating the single tank scram system of a BWR. Hurlebaus, D. (Kraftwerk Union A.G., Offenbach (Germany, F.R.). Abt. R-311 F.); Rosenhauer, W.; Westenberger, G. (Internationale Atomreaktorbau G.m.b.H. (INTERATOM), Bergisch Gladbach (Germany, F.R.)). **22**: No. 4, 231-236(Apr 1977). (In German).

As an alternative to the accumulator tank system, KWU has developed a scram system with single tanks for which a reliability analysis had to be carried out. It was not possible to apply the usual analytical techniques because, as a result of the steady-state behavior of the system, the dynamic nuclear physics conditions for systems failure could not be fixed. The study outlined in this report is an example of a method which allows to prove the technically safe function of a system even if 'failure of the system' as the undesired event cannot be pinpointed at all, or not meaningfully, for nuclear physics reasons, so that the failure probability of the system cannot be ascertained. However, this is based on the precondition that, in the sense of a risk strategy, controllability must not be assessed or proved for incidents and systems defects whose probabilities of occurrence are in a range which allows them to be safely neglected.

870 Study of the perforation of reinforced concrete slabs by rigid missiles. Experimental study, part III. Goldstein, S.; Berriaud, C. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. des Etudes Mecaniques et Thermiques); Labrot, R. (CEA Centre d'Etudes Scientifiques et Techniques d'Aquitaine, 33 - Le Barp (France)). **41**: No. 1, 121-128.(Mar 1977).

The work described is a contribution to the assessment of aircraft hazards for nuclear power plants. A series of tests was performed to outline the behaviour of reinforced concrete slabs impinged by rigid missiles. Prediction of results was tried by means of finite element computation with elastic-plastic constitutive law for the concrete. Although results are encouraging, no general correlation was carried out.

871 Device for cooling core fragments in a fast breeder reactor. Schabert, H.P. (to Siemens A.G., Berlin (Germany, F.R.); Siemens A.G., Muenchen (Germany, F.R.)). German(FRG) Patent 1,764,306/B/. 10 Feb 1977. 5p. (In German).

3 figs.

A device for the safe cooling-down core fragments in a fast gas-cooled breeder reactor, and a distributing and catching device below the fuel element grid for these fragments are proposed. The cooling of the one fragments is taken over by the main coolant of the primary circuit. The distributing device has conical or pyramidal shape and serves - besides its distributing function - to reduce the impact force of the core fragments. The catching device adjacent to the distributing facility consists of radial, slit-shaped cooling packets between which radially running cooling channels for the primary coolant are arranged. In order to improve safety, the primary coolant may be applied together with an auxiliary cooling medium.

872 Recommendations for planning of emergency provisions by nuclear power plant operators. 28: No. 4, 48-56(Feb 1977). (In German).

2 tabs.

Recommendations revised by the SSK Committee and the SSK Commission on April 30th, 1976, and passed by the Laenderausschuss fuer Atomkernenergie (Nuclear Energy Committee of the Laender) on the 15th and 16th July, 1976. In case of incidents or accidents with damage which could lead to an increased emission of radioactive substances into the surroundings of the nuclear power station, adequate emergency provisions of personnel, organizational and technical nature must be taken so that necessary counter measures for the protection of the surroundings can be undertaken effectively and without delay. Alarm schedule for nuclear power stations: it contains measures to be taken at impending danger, damage to persons, fire, radiation accidents or other accidents, for the checking of danger, for assistance, and for the restoration of security. Among these measures are also those necessary for the protection of the surroundings as long as and in so far as they are not taken care of by other authorities according to the official disaster control schedule. The necessary measurements of radiation exposure are to be undertaken in the surroundings of the nuclear power station until the disaster control organization of the authorities takes over. The cooperation of authorities and relief organizations, envisaged in the case of accident and to be arranged beforehand, is also mentioned in the alarm schedule.

873 Corrigendum to the Radiation Protection Ordinance. No. 9, 269(Feb 1977). (In German).

In the correction dated January 21st, 1977 (BGBL. I S. 184), No. 4 has to read as follows: 4. In annex XII on the last page of the 'radiation passport' in subsection 3 of section 49 the correct wording must be 'with regard to women capable of bearing children who have not reached the age of 45 years '.

874 Reactivity insertion accidents. Chapter 14. Ram, K.S. (Indian Inst. of Tech., Kanpur). pp 403-432 of In Elements of nuclear reactor design. Weisman, J. (ed.) (Cincinnati Univ., Ohio (USA). Dept. of Chemical and Nuclear Engineering). Amsterdam, Netherlands; Elsevier (1977).

The dynamic aspects of reactor behaviour are considered. The feedback mechanisms which lead to inherently safe systems are described initially. Analytical models, utilizing these feedback effects for estimation of the maximum energy release due to a reactivity insertion are then examined. This is followed by an examination of some of the specific reactivity insertion accidents considered in the safety analysis of water- and sodium-cooled reactors.

875 Loss-of-cooling accidents. Chapter 13. Weisman, J. (Cincinnati Univ., Ohio (USA). Dept. of Chemical and Nuclear Engineering). pp 371-401 of In Elements of nuclear reactor design. Weisman, J. (ed.) (Cincinnati Univ., Ohio (USA). Dept. of Chemical and Nuclear Engineering). Amsterdam, Netherlands; Elsevier (1977).

Accidents in which cooling of the core is impaired have the potential for very serious consequences to the reactor and staff, and possibly the public. Engineered safeguards must therefore be provided to assure that the staff and public are well protected. The reactor designer must have the ability to analyze the behavior of the system during these accidents, no matter how remote the possibility, in order to demonstrate that the safeguards provided are adequate. This chapter deals with loss-of-flow accidents and loss-of-coolant accidents in various reactor types.

876 Fissile society. Patterson, W.C. London; Earth Resources Research Ltd (1977). 117p.

Critical observations are made about British nuclear power policy, its financing and execution. The subject is dealt with in chapters, entitled: introduction, conventional wisdom; electricity, the energy user; the electricity establishment; the electric nucleus; forecasts and their fulfilment: money for megawatts; saving labour with electricity; power to the powerful; nuclear electricity, future imperative.

877 Method of removing the decay heat of radioactive fission products. Schweiger, F. (to Hochtemperatur-Kernkraftwerk G.m.b.H. (HKG), Uentrop (Germany, F.R.)). German(FRG) Patent 2,516,123/A/. 21 Oct 1976. 17p. (In German).

1 fig.

A method of removing the decay heat of radioactive fission products from helium-cooled high-temperature reactors in particular accidents is proposed. The method is characterized in that water, preferably demineralized water is fed into the core after the onset of the accident when the nuclear reactor is shut down. It is of advantage to feed the water in measured quantities from above into the core while an absorbing agent (e.g. boron compounds) is added to it.

An example is given for required quantity: in case of the THTR, about 2,500 m^3 would be necessary.

878 Earthquakes and aseismatic design standard for nuclear power stations in F.R. Germany. Ide, A. (Fuji Electric Co. Ltd., Tokyo (Japan)). No. 81, 40-47(May 1976). (In Japanese).

Brief history of the earthquakes in F.R. Germany for the period from 1000 to 1969 is reviewed, and comparison of the aseismatic design of nuclear power stations between F.R. Germany and Japan is made. Earthquakes of intensity 7 (maximum acceleration value of 70 to 220 gal) and 8 (that of 150 to 300 gal) could be expected to occur in F.R. Germany, according to European seismic committee. The definitions of safety earthquake (Sicherheitserdbeben) and design earthquake (Auslegungserdbeben) are compared with the Japanese terms, S-2 (maximum possible earthquake giving the strongest vibration to site base) and S-1 (maximum probable earthquake giving the strongest vibration to site base). The total area of F.R. Germany is classified into four zones according to degree of danger. Aseismatic design in F.R. Germany is classified into two classes, whereas that in Japan into three or four classes. In F.R. Germany, either dynamic analysis, simple analysis, or omission of analysis is employed. F.R. Germany employs the waves of El-centro, Taft, etc. of USA as standard, referring to U.S.N.R.C. 1.60 and Housner's equation. The attenuation coefficient and the allowable stress are also compared. A power plant to be exported to Iran is designed at SE of 500 gal and AE of 250 gal, which are approximately equal to the maximum earthquake acceleration for design in Japan.

879 Nuclear safety, 1975. Hetrick, D.L. (ed.). Hinsdale, IL; American Nuclear Society (1975). 335p. (CONF-751044—).

From ANS topical meeting on nuclear safety; Tucson, Arizona, USA (5 Oct 1975).

Separate abstracts are included for 29 of the 31 papers presented on reactor safety, radioactive materials management, criticality accidents, and radioactive waste management. Two of the papers have been previously abstracted and included in ERA.

880 NRC and the nuclear safety community. Mason, E.A. (Nuclear Regulatory Commission, Washington, DC). pp 1-9 of In Nuclear safety, 1975. Hetrick, D.L. (ed.). Hinsdale, IL; American Nuclear Society (1975).

From ANS topical meeting on nuclear safety; Tucson, Arizona, USA (5 Oct 1975).

See CONF-751044—.

The broad and diverse considerations which are subsumed under the heading of nuclear safety, the diversity of interests of the many people and groups who make up the community, the need for fostering and maintaining a community attitude toward nuclear safety, the role of the NRC in the field, and some recent and proposed technical and programmatic approaches are discussed.

881 Risk-benefit and the American Nuclear Society. Okrent, D. (University of California, Los Angeles). pp 10-15 of In Nuclear safety, 1975. Hetrick, D.L. (ed.). Hinsdale, IL; American Nuclear Society (1975).

From ANS topical meeting on nuclear safety; Tucson, Arizona, USA (5 Oct 1975).

See CONF-751044—.

An analysis is presented of the health hazards and economic benefits associated with the development of nuclear power.

882 Nuclear safety experience: key attitudes and events. Morris, P.A. pp 21-37 of In Nuclear safety, 1975. Hetrick, D.L. (ed.). Hinsdale, IL; American Nuclear Society (1975).

From ANS topical meeting on nuclear safety; Tucson, Arizona, USA (5 Oct 1975).

See CONF-751044—.

The purpose of this paper is to review nuclear safety experience in the operation and regulation of commercial nuclear power plants, primarily in the U.S., to try to develop some perspective on nuclear safety.

883 Nuclear safety research at EPRI. Loewenstein, W.B. pp 38-52 of In Nuclear safety, 1975. Hetrick, D.L. (ed.). Hinsdale, IL; American Nuclear Society (1975).

From ANS topical meeting on nuclear safety; Tucson, Arizona, USA (5 Oct 1975).

See CONF-751044—.

The rationale for the EPRI nuclear safety program is described. A description of specific current activities in the program is presented. The specific EPRI-sponsored activities relate to those sponsored by other agencies. Therefore, a brief indication of how the various national and international agencies interact on specific activities is also given.

884 Goals, plans, and programs of government research in reactor safety. Kouts, H. pp 53-62 of In Nuclear safety, 1975. Hetrick, D.L. (ed.). Hinsdale, IL; American Nuclear Society (1975).

From ANS topical meeting on nuclear safety; Tucson, Arizona, USA (5 Oct 1975).

See CONF-751044—.

The US ERDA sponsored research activities related to reactor safety are discussed. The cost-benefit effects of extensive reactor safety requirements are analyzed.

885 Safety in perspective: Deuteronomy to OSHA. Reider, R. (Los Alamos Scientific Lab., NM). pp 63-70 of In Nuclear safety, 1975. Hetrick, D.L. (ed.). Hinsdale, IL; American Nuclear Society (1975).

From ANS topical meeting on nuclear safety; Tucson, Arizona, USA (5 Oct 1975).

See CONF-751044—.

Social concern for safety is traced from Biblical times through the Industrial Revolution and projected through the twentieth century. Nuclear safety leads technology in rigorous requirements although recent legislation for consumer protection is moving in that direction.

886 Role of quality assurance in reactor safety. Roedel, J.A. pp 173-177 of In Nuclear safety, 1975. Hetrick, D.L. (ed.). Hinsdale, IL; American Nuclear Society (1975).

From ANS topical meeting on nuclear safety; Tucson, Arizona, USA (5 Oct 1975).

See CONF-751044—.

A quality assurance program based on common sense, designed to accomplish what is reasonable and necessary, giving proper consideration to safety and economics can be an effective and essential management tool for the design, construction and operation of safe and economical nuclear power plants.

887 Reactor safety, 1975: research progress since the Salt Lake City topical meeting. Johnson, S.O. pp 178-194 of In Nuclear safety, 1975. Hetrick, D.L. (ed.). Hinsdale, IL; American Nuclear Society (1975).

From ANS topical meeting on nuclear safety; Tucson, Arizona, USA (5 Oct 1975).

See CONF-751044—.

Progress in reactor safety research since the Salt Lake City Topical Meeting on Water Reactor Safety (March 1973) is reviewed. Emphasis is placed on significant accomplishments and results. It is concluded that progress has been relatively slow, but considerable acceleration is evident.

ACCIDENT LIABILITY

888 International conventions on civil liability for nuclear damage. Vienna; IAEA (1976). 261p.

Also includes French, Spanish, Russian versions.

This revised edition contains the texts of the following multilateral conventions and instruments concerning civil liability for nuclear damage: The Vienna Convention of 21 May 1963 on Civil Liability for Nuclear Damage; The Paris Convention of 29 July 1960 on Third Party Liability in the Field of Nuclear Energy (incorporating the provisions of the Additional Protocol of 28 January 1964); The Brussels Convention of 31 January 1963; Supplementary to the Paris Convention of 29 July 1960 (and incorporating the provisions of the Additional Protocol signed in Paris on 28 January 1964); and the Brussels Convention of 25 May 1962 on the Liability of Operators of Nuclear Ships. Final Act and Resolutions of the International Conference on Civil Liability for Nuclear Damage, held in Vienna from 29 April to 19 May 1963; Final Act of the International Legal Conference on Maritime Carriage of Nuclear Substances, held in Brussels from 29 November to 2 December 1971; and Convention Relating to Civil Liability in the Field of Maritime Carriage of Nuclear Material, adopted at Brussels on 17 December 1971.

ENERGY STORAGE

889 (EPA—600/2-76-212, pp 435-475) **Preliminary assessment of the role of energy storage and implicated technologies for energy conservation in industry.** Glenn, D.R. (General Electric Co, Philadelphia). Aug 1976.

From Symposium on environment and energy conservation; Denver, Colorado, USA (3 Nov 1975).

In Symposium on environment and energy conservation.

Energy storage is but one possible means for reducing the consumption of fuel and/or electricity within the industrial plant. A twofold approach is underway to identify candidate industries where heat storage can measurably improve energy efficiency and produce a concomitant improvement in operating economics. The methodologies selected to identify candidate industries and processes, the nature of available information, and how additional needed data on energy utilization dynamics are being accomplished are discussed.

FEA and ERDA have recognized a needed focus on current energy-related factors describing the industrial sector and programs to explore applicable conservation techniques. In one such program, the role of energy storage, particularly thermal energy, is synthesized into process designs for a first approximation of cost-benefit and energy conservation impacts afforded by inclusion of this function. Examples of near-term planned or feasible energy storage schemes are shown. With some 40% of the total energy demand related to industrial requirements including space heat, process and direct heat, and boiler heat for steam, the full spectrum of temperature and energy levels are represented. Matching in-plant available excess or reject energy to other compatible needs separated by a time and/or magnitude function, can represent a real opportunity for an energy storage application. Significant design challenges for accomplishing requisite heat/energy exchange and storage in operational industrial energy systems are recognized and discussed.

MAGNETIC

890 (AD-A—039897) **Pulse power systems employing magnetic energy storage. Final report 22 Dec 1975—21 Apr 1977.** Trost, T.F. May 1977. Contract N60921-76-C-0092. 70p. NTIS PC A04/MF A01.

Several basic aspects of pulsed power systems supplying repetitive pulses and using inductive energy storage are investigated. These include the method of inductor charging, the efficiency of discharging with a resistive opening switch, the limitations of thermally driven resistors as opening switches, the design of pulse forming networks for time-varying resistive loads and the relative merits of voltage-fed versus current-fed networks, and some limitations on inductors.

PUMPED HYDRO

891 **Schedule of hydroelectric storage plant using dynamic programming.** Hamilton, H.B.; Viramontes, F.A. (Univ. of Pittsburgh). pp 581-585 of In Modeling and simulation. Volume 7, Part 1. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P1.

The application of the dynamic programming optimization technique to the selection of the pumping and generating schedule of a pumped storage plant is presented. The model is illustrated with an example. In the example the effect that the volume of the reservoir produces on the operating cost of the power system is discussed.

CAPACITOR BANKS

892 (AD-A—039709) **A half megawatt pulse forming network (PFN). Research and development technical report.** Creedon, J.E.; Fitch, R.A. Apr 1977. 8p. (ECOM—4494). NTIS PC A02/MF A01.

A lightweight half megawatt average power pulse forming network (PFN) designed a store 4 kilojoules (kJ) at 40 kilovolts has been developed. The energy storage system produces a 10 microsecond pulse at a repetition rate of 125 hertz and has a one ohm impedance. It is designed to operate adiabatically for durations of 60 seconds. A lifetime capability of over 400,000 pulses has been demonstrated.

FLYWHEELS

893 (UCRL—50033-77-2) **Fiber composite flywheel program. Quarterly progress report, April—June 1977.** Rinde, J.A. 19 Aug 1977. Contract W-7405-ENG-48. 9p. Dep. NTIS, PC A02/MF A01.

Research progress is reported on the following: (1) composites with flexible matrices; (2) composite properties; (3) stress rupture and (4) dynamic fatigue. (TFD)

THERMAL

REFER ALSO TO CITATION(S) 468

CHEMICAL

REFER ALSO TO CITATION(S) 372, 1057

BATTERIES

REFER ALSO TO CITATION(S) 1100, 1101, 1348

894 (EPRI-EM—399-SR) **Lead—acid batteries for utility application: workshop II.** Mar 1977. Contract EX-76-C-01-2114. 185p. (CONF-761235—). Dep. NTIS, PC A09/MF A01.

From 2. workshop on lead-acid batteries for utility application; Washington, District of Columbia, United States of America (USA) (9 Dec 1976).

A separate abstract was prepared for each of the fourteen items included in these proceedings. (RWR)

895 (NTIS/PS—77/0633) **Lead batteries (citations from the NTIS data base). Report for 1964-Jul 77.** Smith, M.F. Aug 1977. 108p. NTIS PC N01/MF N01.

The design, development, components, fabrication, chemistry, and testing of lead batteries are cited in this compilation of Federally funded research. Specific applications for spacecraft, consumer products, and electric vehicles are covered. Studies on lead recovery from battery scrap are covered. Several abstracts on lead toxicity in industrial plants are also cited. (This updated bibliography contains 103 abstracts, 29 of which are new entries to the previous edition.)

896 (NTIS/PS—77/0634) **Lead batteries (citations from the Engineering Index data base). Report for 1970—Jul 77.** Smith, M.F. Aug 1977. 238p. NTIS PC N01/MF N01.

Worldwide research on lead battery components, charging, corrosion, and testing is cited. The majority of studies concern battery use in electric vehicles. Studies on lead recovery from battery scrap and air pollution at battery factories are also included. (This updated bibliography contains 231 abstracts, 53 of which are new entries to the previous edition.)

897 (NTIS/PS—77/0638) **Lithium batteries. Volume 2. 1975—July 1977 (citations from the NTIS data base). Report for 1975—Jul 77.** Smith, M.F. Aug 1977. 168p. NTIS PC N01/MF N01.

Federally funded research on design, development, components, testing, corrosion, electrolytes, sealing and hazards of lithium cells are presented. Batteries studied include lithium organic cells, lithium sulfur cells, lithium-water-air cells and lithium nickel fluoride cells. Applications cover use in spacecraft, electric vehicles, off peak energy storage, and forklift trucks. (This updated bibliography contains 163 abstracts, 89 of which are new entries to the previous edition.)

898 (NTIS/PS—77/0639) **Lithium batteries (citations from the Engineering Index data base). Report for 1970.** Smith, M.F. Aug 1977. 159p. NTIS PC N01/MF N01.

Studies on design, development, components, corrosion and hazards are included in this compilation of worldwide research. Lithium batteries with sulfides, chlorine, thionyl chloride, organic compounds and water are cited. Applications cover use of lithium cells in pacemakers, spacecraft, electric vehicles, and off peak energy storage. (This updated bibliography contains 152 abstracts, 37 of which are new entries to the previous edition.)

899 (X—711-77-28) **1976 Goddard Space Flight Center battery workshop.** Nov 1976. 368p. (CONF-761178—). Space Flight Center, Greenbelt, MD.

From 9. annual battery workshop; Greenbelt, Maryland, United States of America (USA) (9 Nov 1976).

A separate abstract was written for each of the 31 papers presented at the workshop. (RWR)

DESIGN AND DEVELOPMENT

900 (AED-Conf—76-444-016) **Traction batteries for existing and future electric road vehicles.** Salamon, K.; Kraemer, G. 1976. 33p. (In German). (CONF-760866—4). Dep. NTIS (US Sales Only), PC A03/MF A01.

From 4. international electric vehicle symposium; Dusseldorf, German, Federal Republic of (F.R. Germany) (31 Aug 1976).

The report handles the development of traction batteries for road vehicles. It is divided into two parts. In the first part a new lead—acid traction battery is discussed; and in the second, a new nickel oxide—iron battery. The theoretical energy densities for both systems are given. The specific energy values, experimentally attained, lie at about 40 Wh/kg in the case of the lead—acid accumulator and at about 50 Wh/kg in the case of the nickel oxide—iron accumulator. The measures for attaining these values are given. For the lead—acid accumulator the values, attained through experience of electric operation using batteries of this type, are reported. The possibilities of further development are explored. Regarding the use of batteries for powering vehicles, 800 cycles with a lead-acid accumulator and 1,000 cycles with a nickel oxide—iron accumulator can at the moment be calculated. Future research problems are given.

901 (AED-Conf—1976-444-017) **Optimization of the lead—acid battery for powering electric road vehicles.** Friedheim, G. 1976. 15p. (CONF-760866—1). Dep. NTIS (US Sales Only) $3.50.

From 4. international electric vehicle symposium; Dusseldorf, German, Federal Republic of (F.R. Germany) (31 Aug 1976).

The lead—acid battery is a proven electrical storage system which can be used for driving electric road vehicles. This paper reports experiments directed toward optimizing the lead—acid battery for this application. One of the aims was to increase the energy density while maintaining adequate life and ability to withstand cyclic loading. Systematic tests were made with various plate thicknesses and appropriate geometrical plate surface areas. Other factors which improve the energy density and ensure that the lead—acid battery operates with the minimum possible maintenance are also discussed. Improved characteristics can, for example, be achieved with the design and material of the case, paste carrier grids, and plate insulation. 3 figures, 5 tables.

902 (ANL—77-17) **High-performance batteries for stationary energy storage and electric-vehicle propulsion. Progress report, October—December 1976.** Nelson, P.A.; Yao, N.P.; Steunenberg, R.K.; Chilenskas, A.A.; Gay, E.C.; Battles, J.E.; Hornstra, F.; Miller, W.E.; Roche, M.F.; Shimotake, H. Apr 1977. Contract W-31-109-ENG-38. 75p. Dep. NTIS, PC A04/MF A01.

These batteries are being developed for electric vehicle propulsion and for stationary energy storage applications. The present battery cells, which operate at 400 to 450°C, are of a vertically oriented, prismatic design with a central positive electrode of FeS or FeS_2, two facing negative electrodes of lithium—aluminum alloy, and an electrolyte of molten LiCl—KCl. Testing and evaluation of industrially fabricated cells is continuing. During this period, Li—Al/FeS and Li—Al/FeS_2 cells from Eagle-Picher Industries were tested, and tests of Li—Al/FeS cells from Gould Inc. were initiated. The cells are tested individually and in parallel and series battery configurations. These tests provide information on the effects of cell design modifications and alternative materials. Improved electrode and cell designs are being developed and tested at ANL, and the more promising designs are incorporated in the industrially fabricated cells. Among the concepts receiving major attention are carbon-bonded positive electrodes, scaled-up stationary energy storage cell designs, additives to extend electrode lifetime, and alternative electrode separators. The materials development efforts include the development of a new lightweight electrical feedthrough; investigations of new separator materials (e.g., Y_2O_3 powder, Y_2O_3 felt, and porous, rigid ceramics); corrosion tests of materials for cell components; and postoperative examinations of cells. The cell chemistry studies were directed to discharge mechanisms of FeS electrodes, emf measurements of the LiAl/FeS_2 couple at various states of discharge, and studies of other transition-metal sulfides as positive-electrode materials. The advanced battery effort mainly concerned the use of calcium alloys for negative electrode and transition metal sulfides or oxides for the positive electrode. 13 figures, 18 tables.

903 (EPRI-EM—399-SR, pp 53-97) **Study of the manufacturing costs of state-of-the-art lead—acid batteries for peaking power.** Long, A.H. (Westinghouse Electric Corp., Pittsburgh). Mar 1977.

From 2. workshop on lead-acid batteries for utility application; Washington, District of Columbia, United States of America (USA) (9 Dec 1976).

In Lead—acid batteries for utility application: workshop II.

The study examines the sensitivity of cost to the electric utility as a function of parameters that affect the cost to manufacture state-of-the-art lead—acid battery systems. The study shows that under the assumed conditions (effective lead cost of $.19/lb plus the potential benefits of vertical integration in the manufacturing plant), a direct product cost of $29.73/kWh is realistic. The corresponding selling price, assuming low business risk conditions, would be $36.90/kWh at the 4-hour rate ($29.89 at the 10-hour rate). As scrap batteries become available for recycling, the price falls to $29.87/kWh. 9 figures, 14 tables. (RWR)

904 (EPRI-EM—399-SR, pp 98-112) **Lead—acid load-leveling batteries: the ESB tubular concept.** Ferrell, D.T. Jr. (EBS Inc., Yardley, PA). Mar 1977.

From 2. workshop on lead-acid batteries for utility application; Washington, District of Columbia, United States of America (USA) (9 Dec 1976).

In Lead—acid batteries for utility application: workshop II.

Development work on 20-MW, 60-MWh and 20-MW, 100-MWh batteries is summarized. Cell performance projections and battery design features are tabulated. Grid alloys and weights were designed to provide a reliable delivery of the specified energy on the 2000th cycle. Projected battery discharge curves and charging current curves are shown. Improvements in design lowered costs by reducing excess active and inactive material. Manufacturing price estimates and salvage credits are tabulated. Replacement batteries (with scrap credit) of the 20-MW, 60-MWh type were calculated to cost $39.62. 3 figures, 7 tables. (RWR)

905 (EPRI-EM—399-SR, pp 113-125) **Lead—acid battery design for electric utility load leveling.** Hellmann, E.V. (Gould Inc., Langhorne, PA). Mar 1977.

From 2. workshop on lead-acid batteries for utility application; Washington, District of Columbia, United States of America (USA) (9 Dec 1976).

In Lead—acid batteries for utility application: workshop II.

The battery capital cost makes the major contribution to the life cycle cost of a load-leveling facility. This cost can hopefully be minimized by lowering battery price and maintenance costs and increasing life and salvage value. An advanced battery design is described in this paper. The cell is 9.5' x 3' x 4' and of open-tank design. The electrolyte is covered by small hollow glass spheres to reduce water evaporation and electrolyte contamination of the surrounding environment. The pasted-plate battery has approximately the same lead to active material ratios, power densities, and energy densities as standard traction batteries. The recommended charge cycle is shown. Estimated mature production prices vary from $44 to $61, depending on the discharge rate. 5 figures, 3 tables. (RWR)

906 (EPRI-EM—399-SR, pp 127-144) **New lead—acid battery for utility peaking.** Boden, D.P. (C and D Batteries, Plymouth Meeting, PA). Mar 1977.

From 2. workshop on lead-acid batteries for utility application; Washington, District of Columbia, United States of America (USA) (9 Dec 1976).

In Lead—acid batteries for utility application: workshop II.

An advanced design approach for a peaking battery is described. Design criteria include short lead time, high reliability, cost, manufacturing investment, environmental considerations, ease of maintenance, low "fuel" cost, short turn-around time, and good flexibility of usage. Design parameters are tabulated, and typical batteries are sketched. Costs are projected which outline the total cost of manufacture, delivery, and installation of the battery; and application and user considerations are described which show advantages over other forms of bulk energy storage. It is recommended that a 10-MWh system be built to test the design concept without committing large-scale funds. 5 figures, 2 tables. (RWR)

907 (EPRI-EM—399-SR, pp 145-161) **Lead—acid cell of high performance for utility networks.** Towle, W.L. (Globe-Union Inc., Milwaukee). Mar 1977.

From 2. workshop on lead-acid batteries for utility application; Washington, District of Columbia, United States of America (USA) (9 Dec 1976).

In Lead—acid batteries for utility application: workshop II.

Attempts to improve grid design are recounted, and the influence of grid design on electrode discharge characteristics is shown. A cell designed to meet a series of relevant constraints is sketched, and predicted performance characteristics are tabulated. The cell is projected to have a wholesale price of $58 per kWh based on the capacity at the 5-h rate and a lead price of $0.25 per pound. The figure applied to a mature plant producing 135 cells per day. Salvage from used cells would lower the price by $20 per kWh. Economic considerations for embarking on a production program and an estimated time schedule are set forth. 4 figures, 2 tables. (RWR)

908 (EPRI-EM—399-SR, pp 163-187) **Lead—acid battery for electric utilities: a review and analysis.** Birk, J.R. Mar 1977.

From 2. workshop on lead-acid batteries for utility application; Washington, District of Columbia, United States of America (USA) (9 Dec 1976).

In Lead—acid batteries for utility application: workshop II.

The lead—acid battery can be built to meet the technical and siting requirements of the utility industry. The recommended system design is comprised of several hundred to a few thousand 5- to 40-kWh closed, water-cooled cells weighing up to about two tons each. Economics and utility requirements suggest a multi-tier configuration of these cells. A 100-MWh battery (excluding converter and switchgear) of this configuration can be built to occupy a building about two and a half stories high, covering less than one-half acre of land area. The electrical versatility, rapid response, and modular construction of lead—acid batteries offer the utility constructional and operational flexibility unmatched by conventional generating equipment. The major requirements of a large lead—acid energy storage system are minor: controlled energy output (not to exceed very often 100% of rated output); thermal control; specified charging regimes; and control of arsine, stibine, and hydrogen. A five-hour energy-storage plant using lead—acid batteries is conservatively projected to cost $520/kw (1976 dollars). This system cost is made up of the following elements: batteries (55%), converter (15%), and balance of plant (30%). The system should have an energy efficiency of 72%. The battery is anticipated to have a life of 2000 cycles (10 years of normal operation), and replacement batteries will cost about $200/kW. Overall energy costs from such a battery are about 130 mills/kWh. The next logical step leading to commercialization would be a full-scale demonstration plant. Economics of the mature

technology must play a major role in justifying such a demonstration to all parties involved. 6 tables.

909 (EPRI-EM—399-SR, pp 189-198) **Prospects and potential of advanced lead—acid batteries.** Simon, A.C.; Wells, E.E.; Caulder, S. (Naval Research Lab., Washington, DC). Mar 1977.

From 2. workshop on lead-acid batteries for utility application; Washington, District of Columbia, United States of America (USA) (9 Dec 1976).

In Lead—acid batteries for utility application: workshop II.

Work indicated that factors causing the reduction in utilization of active materials can be eliminated. As the PbO_2 electrode is cycled, the structure of the active material undergoes a continuous change that can be correlated with capacity loss. It appears that the same factors that cause poor utilization of active materials and loss of capacity are also responsible for the limited life of the battery. The cell apparently owes its reactivity to the activity of the PbO_2 caused by a disordered structure. As the cell is cycled, the PbO_2 endeavors to revert to a more ordered structure, and the activity decreases. Other work examined the effects of the operating parameters on material utilization. It is necessary to know what, where, and how much reaction occurs within the electrolyte. The amount of product is determined as a function of depth inside the porous plate by automated image analysis. (RWR)

910 (EPRI-EM—399-SR, pp 199-219) **Study of the manufacturing costs of advanced technology lead—acid batteries for peaking power.** Pittman, G.F. Jr. (Westinghouse Electric Corp., Pittsburgh). Mar 1977.

From 2. workshop on lead-acid batteries for utility application; Washington, District of Columbia, United States of America (USA) (9 Dec 1976).

In Lead—acid batteries for utility application: workshop II.

Westinghouse carried out exploratory research on a new lead—acid battery concept that shows promise of significant improvement in the applicability of lead—acid batteries to peaking power service. The concept embodies features which provide long cycle life because of reduced corrosion rates and low first cost because of improved utilization of active materials. An analysis of the direct and indirect costs associated with the operation of a fully integrated, single-product manufacturing facility capable of producing 25 to 40 MWh peaking power batteries per year showed that, in a nominal $.25/lb lead market ($.19/lb cost to a battery fabrication activity), a direct cost of $25.44/kWh (4 hour rate) could be achieved. With a low business risk, the selling price corresponding to the expected return on investment would be $31.62/kWh. With customer-provided scrap the selling price would be $25.85/kWh. These appear to be very attractive prices for a battery with triple the cycle life of state-of-the-art lead—acid batteries. 5 figures, 12 tables. (RWR)

911 (EPRI-EM—399-SR, pp 329-346) **Engineering study of a 20 MW lead—acid battery energy storage demonstration plant.** Stolte, W.J. (Bechtel Corp., San Francisco). Mar 1977.

From 2. workshop on lead-acid batteries for utility application; Washington, District of Columbia, United States of America (USA) (9 Dec 1976).

In Lead—acid batteries for utility application: workshop II.

An engineering study of a 20-MW lead—acid battery energy storage demonstration plant was conducted. Ten alternative designs were evaluated. Plant and battery configurations considered were an open-tank cell, a sealed cell (single layer), a sealed cell (three-tier arrangement), and a sealed cell in weatherproof containers out of doors. The configurations are described in general terms and cost data are tabulated. Four pages of conclusions and recommendations are set out. 2 figures, 6 tables. (RWR)

912 (EPRI-EM—399-SR, pp 347-367) **Summary economic comparisons.** Smith, J.C. (Energy Research and Development Administration, Washington, DC). Mar 1977.

From 2. workshop on lead-acid batteries for utility application; Washington, District of Columbia, United States of America (USA) (9 Dec 1976).

In Lead—acid batteries for utility application: workshop II.

Some crude economic comparisons are made among the various design approaches for lead—acid batteries and the gas turbine alternative through the "screening curve" method. It is concluded that batteries are not competitive under present conditions. 4 figures, 9 tables. (RWR)

913 (EPRI-EM—399-SR, pp 369-373) **Questionnaire.** Mar 1977.

From 2. workshop on lead-acid batteries for utility application; Washington, District of Columbia, United States of America (USA) (9 Dec 1976).

In Lead—acid batteries for utility application: workshop II.

During the second day of the workshop, a questionnaire was given to the utility representatives to obtain their attitude about the prospects for lead—acid batteries, credits for batteries, and implementation of batteries (how they are to be used). The questionnaire is reproduced with the composite responses. (RWR)

914 (UCID—17558(Pt.1)) **High performance metal/air fuel cells. Part 1. General review.** Cooper, J.F. 15 Aug 1977. Contract W-7405-ENG-48. 27p. Dep. NTIS, PC A03/MF A01.

Metal/air fuel cells are reviewed in terms of their potential application in electric vehicles. Attention is focused on those metals (light alkali and alkaline earth metals, and aluminum) which, in combination with oxygen, have theoretical energy densities (2—13 kWh/kg-metal) exceeding that of gasoline (utilized in automobiles at 2—3 kWh/kg). Lithium and aluminum have yielded 8- and 4 kWh/kg, respectively, in laboratory experimental cells. The slurry Zn/air system achieves 0.85 kWh/kg-Zn in prototype vehicle cells and is reviewed for comparison. Calcium can probably yield 1.8 kWh/kg-Ca, but its potential as a fuel has not yet been fully explored. The remaining metals appear to be unsuitable for use in aqueous electrolyte fuel cells. The discharge characteristics of lithium, aluminum, and (possibly) calcium/air cells indicate the potential for electric vehicles of the highway performance and minimum range (300 miles) of subcompact automobiles, rapid refueling for unlimited range extension, and the storage in the fuel cell of sufficient metal for ranges in excess of 1000 miles. Barriers to the concept are the economic necessity of recycling cell reaction products (except in the case of calcium), the expansion or creation of vast metal production industries, and the change-over of existing service station infrastructures to allow electric vehicle servicing. The energy efficiency of a transportation system using aluminum was estimated using data on the current aluminum production industry. The total estimated cost of ownership and operation of an aluminum/air cell was 3.0—3.6 cents/km. The relative rarity of lithium would complicate its use. 6 tables.

915 (X—711-77-28, pp 3-9) **NASA objectives and the space power program.** Mullin, J. (National Aeronautics and Space Administration, Washington, DC). Nov 1976.

From 9. annual battery workshop; Greenbelt, Maryland, United States of America (USA) (9 Nov 1976).

In 1976 Goddard Space Flight Center battery workshop.

Objectives of NASA for the space power program are reviewed. The effort is directed into solar cells and arrays, chemical energy conversion and storage, thermal energy conversion, and power conditioning. The chemical energy conversion programs include primary and secondary batteries and fuel cells. Goals of the various programs and the approach chosen to meet them are set forth. 7 figures. (RWR)

916 (X—711-77-28, pp 35-39) **Manufacturing variables.** Armantrout, J.D. (Aeronutronic Ford, Palo Alto, CA). Nov 1976.

From 9. annual battery workshop; Greenbelt, Maryland, United States of America (USA) (9 Nov 1976).

In 1976 Goddard Space Flight Center battery workshop.

The characteristics of a 20-Wh/lb Ni/Cd battery developed for the NATO III Communications Satellite are discussed. Cell negative electrode efficiency as related to cycle life is plotted; as cycle life begins to increase, there is an increase in the peak voltage that tends to stabilize, usually after 25 to 30 cycles. Lower electrode efficiency contributes to higher charge voltages. It is concluded that the negative electrode utilization variable has significant effect on the cell negative-to-positive ratio. The minimum negative electrode utilization requirement should be controlled to preclude long-term peak cell voltage problems related to inadequate overcharge capacity. 6 figures. (RWR)

917 (X—711-77-28, pp 41-54) **Lightweight cells in batteries.** Schulman, I. (TRW Systems, Redondo Beach, CA). Nov 1976.

From 9. annual battery workshop; Greenbelt, Maryland, United States of America (USA) (9 Nov 1976).

In 1976 Goddard Space Flight Center battery workshop.

Recent work at TRW concerned with the manufacture of light-weight Ni/Cd cell and battery systems is discussed. High-energy density electrodes made by electrochemical deposition and vacuum impregnation were evaluated; the former performed better. The battery system developed yields 21.4 Wh/kg and a 65% DOD. New technology was developed with respect to Ti end plates, Al-plated thermal shims, anodized shims for electrical insulation, and a new terminal concept. 16 figures. (RWR)

918 (X—711-77-28, pp 97-103) **Cell design.** Halpert, G. Nov 1976.

From 9. annual battery workshop; Greenbelt, Maryland, United States of America (USA) (9 Nov 1976).

In 1976 Goddard Space Flight Center battery workshop.

The Standard 20-Ah nickel—cadmium cell program is reviewed. The report is devoted to the Standard cell design; there are no test results as yet. 7 figures. (RWR)

919 (X—711-77-28, pp 129-137) **Design details, 50-ampere hour cell.** Scott, W. (TRW Systems, Redondo Beach, CA). Nov 1976.

From 9. annual battery workshop; Greenbelt, Maryland, United States of America (USA) (9 Nov 1976).

In 1976 Goddard Space Flight Center battery workshop.

Details of the design of a 50-Ah Ni/Cd cell are summarized. Drawings and a table of specifications are presented. Modifications of plates for signal electrodes are also considered. 13 figures. (RWR)

920 (X—711-77-28, pp 139-179) **Panel/attendee discussion on cell design.** Nov 1976.

From 9. annual battery workshop; Greenbelt, Maryland, United States of America (USA) (9 Nov 1976).

In 1976 Goddard Space Flight Center battery workshop.

This discussion centers on cell design as it relates to energy density and life reliability. Several of the panel members made brief presentations on weight distributions of battery components and their improvement, changes in crystal structure in the electrodes, and electrochemical design parameters. 12 figures. (RWR)

921 (X—711-77-28, pp 275-283) **Pioneer Venus probe battery program.** Bell, J.E. (Hughes Aircraft, Los Angeles). Nov 1976.

From 9. annual battery workshop; Greenbelt, Maryland, United States of America (USA) (9 Nov 1976).

In 1976 Goddard Space Flight Center battery workshop.

The requirements of the Pioneer Venus probe make design of the silver—zinc battery rather difficult. Requirements and design features are tabulated. Cell and battery assembly sketches are shown, along with the pressure release valve. Battery case and thermal control components are described. 12 figures. (RWR)

922 (X—711-77-28, pp 290-295) **Advanced sealed nickel—cadmium design.** Miller, L. (Eagle-Picher Industry, Joplin, MO). Nov 1976.

From 9. annual battery workshop; Greenbelt, Maryland, United States of America (USA) (9 Nov 1976).

In 1976 Goddard Space Flight Center battery workshop.

A design based on the advanced electrode stack technology devised for metal/H_2 cells is explained. The Ni/Cd cell is basically conventional, except that the negative electrode is split, with a gas spacer between the two parts. A gas electrode, designed to recombine H_2 gas, is connected to the positive terminal. Several variations of cell design were evaluated. 5 figures. (RWR)

923 (X—711-77-28, pp 337-351) **GSFC's position on the nickel—hydrogen system.** Ford, F. (Goddard Space Flight Center, Greenbelt, MD). Nov 1976.

From 9. annual battery workshop; Greenbelt, Maryland, United States of America (USA) (9 Nov 1976).

In 1976 Goddard Space Flight Center battery workshop.

This paper begins with a comparison between work done on Ni/H_2 batteries and that done on Ni/Cd batteries. Considerable discussion was evoked on thermal conditions in the Ni/H_2 battery, as well as volume and overcharge considerations. Results of cyclic voltametry measurements on Ni/Cd cells were also presented and discussed. 3 figures. (RWR)

PERFORMANCE AND TESTING

924 (X—711-77-28, pp 13-27) **Vibrational effects on sealed nickel—cadmium cells.** Gross, S. (Boeing Aerospace Co., Seattle). Nov 1976.

From 9. annual battery workshop; Greenbelt, Maryland, United States of America (USA) (9 Nov 1976).

In 1976 Goddard Space Flight Center battery workshop.

The effects of strenuous vibration on sealed nickel—cadmium cells were studied. Causes of cell failure and methods to eliminate them were investigated. It was learned that compression improves resistance to vibration. A design curve was obtained. Compression also separates the natural frequencies of the battery case and the cell. 24 figures. (RWR)

925 (X—711-77-28, pp 55-67) **Cycle life performance testing, Heliotek 50-ampere hour cells.** Pickett, D. (Wright-Patterson Air Force Base, OH). Nov 1976.

From 9. annual battery workshop; Greenbelt, Maryland, United States of America (USA) (9 Nov 1976).

In 1976 Goddard Space Flight Center battery workshop.

Construction and performance testing of Ni/Cd cells for geosynchronous satellite usage are discussed. Low end-of-discharge voltages and high charge voltages were noted; these were attributed to insufficient electrolyte. 18 figures. (RWR)

926 (X—711-77-28, pp 71-80) **Accelerated test.** McDermott, P. (Coppin State Coll., Washington, DC). Nov 1976.

From 9. annual battery workshop; Greenbelt, Maryland, United States of America (USA) (9 Nov 1976).

In 1976 Goddard Space Flight Center battery workshop.

If accelerated test data are to be correlated with real life test data, it is necessary that failures in accelerated tests be understood. The author examined accelerated test results from the point of view of the chemical changes going on, not in terms of regression or statistical analysis, and attempted to correlate them with modes of failure or degradation. 7 figures. (RWR)

927 (X—711-77-28, pp 81-87) **JPL test plan for evaluation of new technology, nickel—cadmium cells.** Bogner, R.S. (Jet Propulsion Labs., Padadena, CA). Nov 1976.

From 9. annual battery workshop; Greenbelt, Maryland, United States of America (USA) (9 Nov 1976).

In 1976 Goddard Space Flight Center battery workshop.

The objective of the test plan was to compare different Ni-cad cell types to determine life in comparison to the Goddard Space Flight (GSF) cells on the accelerated life test program. A second objective was to determine if the regression equation for the life of the GSF cells is appropriate for other cells and cell sizes. A factorial experiment was designed; factors of concern at JPL were KOH concentration, precharge, and KOH volume. Cells of 6, 20, and 25 Ah were to be tested. The testing program was still underway. 8 figures. (RWR)

928 (X—711-77-28, pp 89-95) **Cell design.** Baer, D. Nov 1976.

From 9. annual battery workshop; Greenbelt, Maryland, United States of America (USA) (9 Nov 1976).

In 1976 Goddard Space Flight Center battery workshop.

Six- and 12-Ah Ni/Cd cells manufactured for the IUE program are compared. Cell design, manufacturing data, and acceptance test data obtained at GE and Goddard are included. The cells were GE cells with dual nickel braze, ceramic-to-metal seals, and pellon 2505 separator; negatives were teflonated. Pressures and cell voltages are tabulated. Five cells were cycled as for a 24-h orbit; initially there was a capacity at 0C of 6.3 Ah, but this increased to 7.1 Ah after about 50 cycles. 7 figures. (RWR)

929 (X—711-77-28, pp 105-109) **Battery cell design priorities for geosynchronous orbit communications satellite.** Steinhauer, R. (Hughes Aircraft Co., Los Angeles). Nov 1976.

From 9. annual battery workshop; Greenbelt, Maryland, United States of America (USA) (9 Nov 1976).

In 1976 Goddard Space Flight Center battery workshop.

A brief overview is given on what constitutes a communications satellite system and how the battery requirements are determined. Batteries are about 1% of the cost and 10% of the mass of an on-station satellite. What is needed is a battery which will perform well for 1000 to 2000 charge/discharge cycles to nearly 80% depth of discharge over 10 to 15 years. Long life must not be sacrificed for high energy density. 4 figures. (RWR)

930 (X—711-77-28, pp 111-127) **Nickel—cadmium, state-of-the-art assessment of communications satellites.** Krause, S. (Hughes Aircraft Co., Los Angeles). Nov 1976.

From 9. annual battery workshop; Greenbelt, Maryland, United States of America (USA) (9 Nov 1976).

In 1976 Goddard Space Flight Center battery workshop.

Data from typical synchronous satellite battery life tests are shown. These examine electrode thickness vs time, chemical composition of electrodes, time dependence of electrolyte in separators and electrodes, time dependence of cadmium migration, etc. Predominant wearout mechanisms are considered, and steps required to obtain Ni-cad systems of very long life are suggested. Research in separator properties and reaction kinetics will probably be needed. 18 figures. (RWR)

931 (X—711-77-28, pp 185-190) **Reconditioning of RCA STATCOM batteries in orbit.** Napoli, J. (RCA American Communications, Piscataway, NJ). Nov 1976.

From 9. annual battery workshop; Greenbelt, Maryland, United States of America (USA) (9 Nov 1976).

In 1976 Goddard Space Flight Center battery workshop.

Background information on the SATCOM cells, their history, and how long they have been operating is presented. The SATCOM design is a direct energy transfer power system. There are three batteries of 22 cells each, on a parallel charge; that is, each battery has its own charger. Basic cell design and operating parameters are tabulated. Cells have operated in orbit about a year so far, and have been reconditioned twice. Data on battery voltages are shown. 5 figures. (RWR)

932 (X—711-77-28, pp 191-197) **Performance characteristics of reconditioned batteries on the CTS.** Lackner, J. (Defense Research Establishment, Shirley Bay, Ont.). Nov 1976.

From 9. annual battery workshop; Greenbelt, Maryland, United States of America (USA) (9 Nov 1976).

In 1976 Goddard Space Flight Center battery workshop.

Data on battery reconditioning performed on cells in the Communication Technology Satellite are presented. Principal cell design and operating characteristics are given. The change in voltage of the 5-Ah (nominal) Ni/Cd batteries during reconditioning is shown. 4 figures. (RWR)

933 (X—711-77-28, pp 199-213) **Life tests and reconditioning.** Scott, W.R. (TRW Systems, Redondo Beach, CA). Nov 1976.

From 9. annual battery workshop; Greenbelt, Maryland, United States of America (USA) (9 Nov 1976).

In 1976 Goddard Space Flight Center battery workshop.

Some data on ground life tests involving reconditioning are presented. Accelerated synchronous-orbit-type tests were done on batteries with polypropylene and with nylon separators; the tests were continued for 14 and 10 eclipse seasons, respectively. Maximum, minimum, and mean end-of-discharge voltages are plotted, and the effects of reconditioning are shown. It is concluded that, after a battery has been discharged extensively, particularly at high depths of discharge (84%), the method of reconditioning is very important. Discharge to a relatively high battery voltage becomes less and less effective as the number of cycles increases; one must discharge the cells to a much lower voltage. A comparison between cells which were and were not reconditioned is also made. Rather extensive discussion followed this paper. 4 figures. (RWR)

934 (X—711-77-28, pp 215-222) **Cycle life and storage test results.** Bogner, R.S. (Jet Propulsion Labs., Pasadena, CA). Nov 1976.

From 9. annual battery workshop; Greenbelt, Maryland, United States of America (USA) (9 Nov 1976).

In 1976 Goddard Space Flight Center battery workshop.

Nickel—cadmium cycle life and storage test results are discussed. A description of the test cells, previous test history, cycle test outline and results, and storage test outline and results are presented. Thirty cells were purchased from each of three manufacturers. It was concluded from the storage test that no one storage was significantly better than another. 11 figures. (RWR)

935 (X—711-77-28, pp 223-228) **Accelerated life tests on NATO III batteries.** Armantrout, J.D. (Aeronutronic Ford, Palo Alto, CA). Nov 1976.

From 9. annual battery workshop; Greenbelt, Maryland, United States of America (USA) (9 Nov 1976).

In 1976 Goddard Space Flight Center battery workshop.

Information on a 20-Wh/lb battery is presented. The test procedures are described. Effects of capacity degradation are pointed out. The difference between maximum and minimum end-of-discharge voltages increased until about the fifth eclipse season and then diminished, regardless of whether the cells were reconditioned or not. It was concluded that lightweight battery packaging design did demonstrate the capability to meet seven-year mission requirements. The reconditioning tends to improve early-life discharge voltage performance and also the end-of-life discharge capacity characteristics. It was found that the reconditioned portion of the battery had approximately 25% more capacity at the end of the test than the unreconditioned. 5 figures. (RWR)

936 (X—711-77-28, pp 229-232) **HEAO cell parametric tests.** Paschal, E. (Marshall Space Flight Center, Huntsville, AL). Nov 1976.

From 9. annual battery workshop; Greenbelt, Maryland, United States of America (USA) (9 Nov 1976).

In 1976 Goddard Space Flight Center battery workshop.

The results of the parametric testing on the HEAO cell, a 20-ampere SAFT cell, are presented. This is a comparison between two production runs, approximately a year apart. The designs between the two production runs were different. The plate loading on group 2 was lower. The positive capacity was similar for the two groups, but the negative capacity was substantially higher for the first group. Results for group 1 at the end of 500 cycles were lower than those for group 2 at 1000 cycles. 3 figures. (RWR)

937 (X—711-77-28, pp 245-253) **Viking battery ground and flight test results.** Newell, B. (Martin Marietta Corp., Denver). Nov 1976.

From 9. annual battery workshop; Greenbelt, Maryland, United States of America (USA) (9 Nov 1976).

In 1976 Goddard Space Flight Center battery workshop.

Data on the polypropylene cells used on the Viking mission are presented. Cell specifications, characteristics, and steps in manufacturing are tabulated. Plots of the following information are given: cell self-discharge characteristic, effects of trickle charge on voltage, end-of-charge and end-of-discharge voltages as functions of thousands of cycles, and battery and cell voltage characteristics after 8568 cycles. 13 figures. (RWR)

938 (X—711-77-28, pp 255-265) **Viking orbiter battery design and performance.** Bogner, R.S. (Jet Propulsion Labs., Pasadena, CA). Nov 1976.

From 9. annual battery workshop; Greenbelt, Maryland, United States of America (USA) (9 Nov 1976).

In 1976 Goddard Space Flight Center battery workshop.

The design of the spacecraft and the battery is described. A battery performance mission simulation test is discussed, and data on battery performance during the actual mission of the VO I spacecraft are presented. Some problems arising during procurement and fabrication of the battery are summarized. 8 figures. (RWR)

939 (X—711-77-28, pp 267-272) **Nickel hydrogen battery hazardous test facility.** Gandel, M. Nov 1976.

From 9. annual battery workshop; Greenbelt, Maryland, United States of America (USA) (9 Nov 1976).

In 1976 Goddard Space Flight Center battery workshop.

A chamber for the testing of nickel/hydrogen batteries is described. Special precautions are necessary, of course, because of the presence of hydrogen. The discussion following this paper pointed out the evolution of hydrogen from nickel/cadmium batteries, and suggested that Ni/H_2 batteries might actually be the safer ones. 3 figures. (RWR)

940 (X—711-77-28, pp 285-289) **Silver—hydrogen life testing.** Armantrout, J.D. (Aeronutronic Ford, Palo Alto, CA). Nov 1976.

From 9. annual battery workshop; Greenbelt, Maryland, United States of America (USA) (9 Nov 1976).

In 1976 Goddard Space Flight Center battery workshop.

Data on the Ag/H_2 system are discussed. The stack configuration and charge--discharge characteristics are shown. The following conclusions were reached: the Ag/H_2 energy storage system has a demonstrated cycle life capability of at least 2000 deep discharge cycles and a calendar life of at least one year; optimum charge control of Ag/H_2 cells improves cell performance and eliminates cell stack electrolyte loss; replacement of the Ni/H_2 system with Ag/H_2 should significantly improve space battery energy density and simplify electrolyte and thermal management requirements. 4 figures. (RWR)

941 (X—711-77-28, pp 297-309) **Failure mechanisms in nickel—hydrogen cells.** Holleck, G. (EIC Corp., Newton, MA). Nov 1976.

From 9. annual battery workshop; Greenbelt, Maryland, United States of America (USA) (9 Nov 1976).

In 1976 Goddard Space Flight Center battery workshop.

Results of experimental investigations of proposed solutions to the problem of failure in Ni/H_2 cells are discussed. The overall program includes component-level investigations geared to identifying the important steps and the mechanisms associated with oxygen and electrolyte management, demonstration of the feasibility of cells with improved design, and construction of experimental cells for extensive testing. Specific studies involved electrodes, oxygen recombination, electrolyte loss from the stack and its prevention. The main conclusions of this part of the work were that oxygen concentration is determined by diffusion path and that the principal electrolyte loss mechanism is displacement; the solution was incorporation of reservoirs and membranes in an appropriately designed stack configuration. Several designs are shown, and test data are presented. The following conclusions were drawn: lack of electrolyte limits high-rate performance; the main electrolyte loss mechanism is displacement; high thermal gradients lead to H_2O loss; O_2 concentration is acceptable in conventional arrangements, but lowest in a recirculating configuration; trapped O_2 is larger in cells with a reservoir. The recommendation is for a cell configuration with optimized reservoir. 20 figures. (RWR)

942 (X—711-77-28, pp 311-315) **Oxygen equilibrium measurements in nickel—hydrogen cells.** Rogers, H.H. (Hughes Aircraft, Los Angeles). Nov 1976.

From 9. annual battery workshop; Greenbelt, Maryland, United States of America (USA) (9 Nov 1976).

In 1976 Goddard Space Flight Center battery workshop.

Different workers reported very large differences in the oxygen concentration in Ni/H_2 cells. The object of this work was to determine if EIC and ERD hydrogen electrodes have different activity for oxygen reduction. Apparatus and procedures for making the measurement are described, and a typical electrode recorder trace is shown. The following results were obtained: temperature increased from 22.5° to 47°C; current increased about 20%; O_2 solubility was lower; and diffusion rate was greater. The effects of temperature rises were studied. It was found that the differences reported were due to differences in the electrodes. The reaction is diffusion limited, as indicated by the small temperature coefficient. TFE backing can reduce the recombination rate significantly. Electrodes should be designed for high activity with diluted oxygen, and characterized for oxygen recombination before use in Ni/H_2 cells. 8 figures. (RWR)

943 (X—711-77-28, pp 327-335) **Cycle life test and thermal vacuum test results in nickel—hydrogen cells.** Sayano, R. (TRW Systems, Redondo Beach, CA). Nov 1976.

From 9. annual battery workshop; Greenbelt, Maryland, United States of America (USA) (9 Nov 1976).

In 1976 Goddard Space Flight Center battery workshop.

The first part of this paper contains a summary of life cycle tests on nickel—hydrogen cells of various vintages. The second part presents results of thermal vacuum tests on 10-cell, 35-Ah Ni/H_2

batteries designed and fabricated under the sponsorship of Comsat. End-of-discharge cell voltages are shown. Engineering details involved in performing the tests are elucidated. 12 figures. (RWR)

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 901, 941, 942, 950

944 (AD-A—039735) **Nickel/cadmium aircraft batteries: multichannel gassing-rate meter. Technical note.** Feldman, K.; Haines, R.L. Mar 1977. 24p. (DREO-TN—77-5). NTIS PC A02/MF A01.

The instrument described is used to assess the state of health of separators in nickel/cadmium aircraft batteries, and thus to permit removal from service of those cells which may be expected to fail catastrophically in the near future. Twenty channels are provided to permit simultaneous observation of all cells in a complete battery. Each channel measures the rate of emission of gas from one cell during overcharge by means of the pressure build up in a chamber from which the gas escapes via a suitable orifice. Construction, calibration and cleaning are discussed.

945 (AD-A—039899) **Solid electrolyte battery materials. Technical report.** Huggins, R.A. 30 Nov 1974. Contract N00014-67-A-0112-0075. 145p. (CMR—74-16). NTIS PC A07/MF A01.

This is the third technical report relating to work on Solid Electrolyte Battery Materials. During the past 18 months our efforts have had two major aims: one is to develop a novel technique for producing beta alumina solid electrolytes for use in the sodium-sulfur cell. The other is to search for new fast ion conducting materials for lithium and potassium ions, as well as to examine mixed conductor materials for potential application as electrodes in advanced secondary battery designs. The details and results of our efforts for the first year are presented in Technical Report No. 2. The present report covers the first six months of effort in the second year.

946 (X—711-77-28, pp 223-244) **Nickel hydroxide electrodes.** Dunlop, J. (COMSAT Labs., Clarksburg, MD). Nov 1976.

From 9. annual battery workshop; Greenbelt, Maryland, United States of America (USA) (9 Nov 1976).

In 1976 Goddard Space Flight Center battery workshop.

Work on nickel electrodes showing the effects of cyclic life is reported. Characteristics of electrochemically and chemically impregnated nickel oxide electrodes are compared. An analysis that breaks down the loading of the various electrodes on a percent by weight basis is also shown. A cross section of a conventional chemically impregnated electrode obtained by SEM indicates that active material moves from the center of the electrode toward the surface and compacts there after prolonged operation (3 years). There was a large increase in the micropore structure of the positive electrode as a result of the compacting of the active material. There is a large increase in void volume in the center of the electrode. The compacting at the electrode surface acts as a wicking device to suck electrolyte out of a nylon-type separator. During the lengthy discussion of this paper, the effects of Co in an electrochemically impregnated electrode on flooded cell cycling test was reported. A 5% addition increased cycle life by about a factor of 5. 5 figures. (RWR)

947 (X—711-77-28, pp 317-326) **Development of nickel oxide electrodes for use in nickel—hydrogen cells.** Puglisi, V.J. (Yardney Electric, Pawcatuck, CT). Nov 1976.

From 9. annual battery workshop; Greenbelt, Maryland, United States of America (USA) (9 Nov 1976).

In 1976 Goddard Space Flight Center battery workshop.

The program had two primary tasks: to develop improved nickel oxide electrodes and to fabricate and deliver these electrodes. The aspects discussed in this paper are the plaque porosity and the loading level of the positive electrode. As a group, cells with 82% porous electrodes performed better than those with 78%; electrodes with a loading of 1.6 g/cm^3 performed as well as those with 1.9 g/cm^3. It was found that capacity did not improve during stabilization tests. The goal of 60 mAh/cm^2 of electrode in the back-to-back configuration was met. Capacity and utilization data for test cells are tabulated. 11 figures. (RWR)

APPLICATIONS

948 (EPRI-EM—399-SR, pp 4-28) **Economic assessment of the utilization of lead—acid batteries in electric utility systems.** Johnson, A.C.; Hynds, J.A.; Nevius, D.R. (Public Service Electric and Gas Co., Newark, NJ). Mar 1977.

From 2. workshop on lead-acid batteries for utility application; Washington, District of Columbia, United States of America (USA) (9 Dec 1976).

In Lead—acid batteries for utility application: workshop II.

The purpose of this study is to search for and identify specific applications in which lead/acid batteries might be economically competitive on an electric utility system. Particular attention is given to searching the PSE and G system for installations of batteries which could defer or cancel costly transmission and/or distribution projects. The report analyzes and summarizes all costs and savings attributable to lead/acid batteries. The following conclusions were reached: with the base data, total savings could not be identified which could justify installation of lead/acid batteries, in spite of very substantial transmission savings; no single credible parameter change was identified which, by itself, would justify the batteries; for a lead/acid battery installation to be economic at presently estimated costs, large transmission savings, large amounts of off-peak nuclear or other base load energy for charging, and/or large fuel cost differentials are needed. 5 figures, 10 tables. (RWR)

949 (EPRI-EM—399-SR, pp 30-52) **Economic assessment of lead—acid batteries for non-generating utilities and large industrial customers.** Shah, K.R.; Prabhakara, F.S. (Gilbert/Commonwealth, Jackson, MI). Mar 1977.

From 2. workshop on lead-acid batteries for utility application; Washington, District of Columbia, United States of America (USA) (9 Dec 1976).

In Lead—acid batteries for utility application: workshop II.

For evaluating the economic feasibility of application of large lead—acid batteries, three representative systems were initially selected. The criteria used in selecting these representative non-generating systems were size of load demand, peaking cycle (winter or summer), load factor, duration of peak, ratio of valley to peak load, type of rate structure, and geographic distribution. Systems with load factors in excess of 0.9 were eliminated. The selected loads were one non-generating utility; a Rural Electrification Administration cooperative in the Midwest; and two large industrial customers; an automotive foundry in the Midwest and a steel products company in the mid-Atlantic region. Preliminary results indicated that the use of large batteries is not economic at this time. Changing power rates will probably make use of batteries by large industrial companies economic in the future. 9 figures, 4 tables. (RWR)

950 (EPRI-EM—399-SR, pp 221-327) **Study of the auxiliaries for lead—acid battery systems for peaking power.** Vaill, R.E. (Westinghouse Electric Corp., Pittsburgh). Mar 1977.

From 2. workshop on lead-acid batteries for utility application; Washington, District of Columbia, United States of America (USA) (9 Dec 1976).

In Lead—acid batteries for utility application: workshop II.

This work considers the elements of the peaking power battery system which are neither the cells nor the power converter hardware per se, but which are nonetheless required to make the system work. These elements are termed the peaking power battery auxiliaries. The auxiliaries fall into two functional groups, those pertaining to operational aspects of the batteries and those related to safety and protection. The study is broken into two major tasks. The first task is concerned with the definition of the requirements for the auxiliaries, creation of a conceptual design which meets the requirements, and the performance of a cost estimate of that design. The second major task delineates the effects of changes in auxiliaries design. System reliability is addressed by investigating the interplay of system dc voltage, level of monitoring, and cell failure rate on the system cost and performance. The impact of cooling and ventilation system design is evaluated with particular emphasis on effects of varying climatic conditions. The selection of auxiliaries has a significant impact on the total system initial costs, repair and replacement costs, and system availability. 24 figures, 24 tables. (RWR)

ENERGY MANAGEMENT AND POLICY

951 (ORNL/ICES—1) **ICES: Information Center for Energy Safety.** Cottrell, W.B.; Hoy, H.C. 8 Aug 1977. Contract W-7405-ENG-26. 29p. Dep. NTIS, PC A03/MF A01.

A brief history of the Information Center for Energy Safety (ICES) activities during one year of operation is described. The center is uniquely concerned with safety considerations and relevant standards useful in the development, design, construction, and operation of all energy systems except nuclear. The present services of ICES, which include answers to technical inquiries, personalized information searches, state-of-the-art reviews of the safety of various energy systems, selective dissemination of information capability, and articles in the National Safety Council's newsletter, are discussed. To provide these services, ICES uses information sources such as the ORNL library system, the ERDA computerized data files found on RECON, the affiliated data systems, and the consultant services of the scientific staff of ORNL and technical personnel of the UCCND Engineering and Development Division. Although ICES will be on RECON, its listing there is primarily to direct users to the most relevant data bases for their needs. Additional services and capability are planned.

952 Department of Energy Organization Act. Conference report to accompany S. 826. Washington, DC; Committee of Conference (1977). 106p. GPO.

The committee of conference submitted the report on the disagreeing votes of the two Houses on the amendment of the House to the bill (S. 826) to establish a Department of Energy in the executive branch by the reorganization of energy functions in order to secure effective management to assure a coordinated national energy policy. Presented in the first portion of this report are the ten Titles in Sec. 2, Definitions, namely: Declaration of Findings and Purposes, Establishment of Department, Transfers of Functions, Federal Energy Regulatory Commission, Administrative Procedures and Judicial Review, Administrative Provisions, Transitional, Savings, and Conforming Provisions, Energy Planning, Effective Date and Interim Appointments, and Sunset Provisions, in which Sec. 1001 states "not later than January 15, 1982, the President shall prepare. . . a comprehensive review of each program of the Department." The second portion of this report presents the joint explanatory statement of the committee of conference regarding each of the ten Titles. (MCW)

953 Energy statistics: 1973/1975. Paris; Organisation for Economic Co-Operation and Development (1976). 241p. (In English and French). .

The publication provides detailed statistics on production, trade, and consumption for each source of energy in all OECD countries. The publication consists of two parts. The first part provides statistics from 1960 to 1975 for the OECD as a whole, the United States, European Economic Community, and Japan. The second part consists of a detailed analysis of all energy sources in 1973, 1974, and 1975 for each OECD country and for the OECD total, OECD Europe, the European Economic Community and North America. The tables cover all commercial sources of energy, both primary (hard coal, brown coal, natural gas, crude petroleum, and hydroelectric power, geothermal and nuclear power) and secondary.

ENERGY ANALYSIS AND MODELING

REFER ALSO TO CITATION(S) 299, 420, 516, 517, 518, 588, 962, 964, 965, 966, 974, 978, 987, 1002, 1003, 1004, 1005, 1013, 1014, 1030, 1031, 1032, 1033, 1036, 1038, 1040, 1073, 1075, 2024, 2025

954 (BNL—50642) **Validation and assessment of the RESPONS model.** Goldberg, M.D.; Cherniavsky, E.A. Dec 1976. Contract EY-76-C-02-0016. 139p. Dep. NTIS, PC A07/MF A01.

A critical validation and assessment has been performed on the "Regional Energy System for the Planning and Optimization of National Scenarios" (RESPONS) model for ERDA/AFE. The objectives of the study were to determine the utility and quality of the model and data base, as published by the model developer, and evaluate the applicability of the model and data to relevant policy concerns. The model structure was examined, and constraints and assumptions were identified. Runs were performed to test the sensitivity of the model results to data input and implicit and explicit assumptions. The tables contained in the data base were examined as to methods for generation, sources of information, assumptions used, algorithms develped, quality limitations, and ease of modification. A few data areas were explored in detail. Conclusions pertinent to the objectives of the study were summarized, and recommendations as to possible modifications to the model and data base which would enhance model applicability and performance were provided.

955 Energy circuit language of H. T. Odum: a tutorial exposition. Sedlik, B.R.; Capehart, B.L.; Robertson, T.A. (Univ. of Florida, Gainesville). pp 366-371 of In Modeling and simulation. Volume 7, Part 1. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P1.

This paper describes the motivation, development, and application of Energy Circuit Language (a modeling and simulation language) as developed by H. T. Odum. With origins in the biological sciences, Energy Circuit Language (Energese) has evolved into a complete modeling language for the description and delineation of systems. The attractiveness of Energese as a modeling tool arises from its ability to transform the myriad of type and form of real-world flows and storages found in natural and social systems into a singular set of energy components that can be analyzed, utilizing the laws and principles of thermodynamics. Such a methodology enhances model credibility by eliminating the need for arbitrary functions to link dissimilar flows and storages and provides a means to isolate erroneous model formulations that violate thermodynamic foundations. In addition, the pictorial mode of Energese facilitates model formulation and subsequent evaluation of static and dynamic system behavior. Static evaluation, useful in net energy analysis, can be accomplished by direct enumeration of model pathways on an Energese system diagram while dynamic response can be accomplished by translating the Energese diagram into a set of differential equations for subsequent analog or digital computer simulation. Although other modeling techniques and languages are capable of duplicating the results of Energese models, the forte of Energese is that it provides the modeler with a macro-perspective of systems that reveals fundamental arrangements of structure across and within the spectrum of system scale. From such a framework, the modeling task proceeds from a "top-down" rather than a "bottom-up" approach thus reducing the expense and complications of including intricate and unnecessary detail. This paper is intended as a self-contained reference of Energese for the experienced modeler. 5 figures, 15 references.

956 Development of a system dynamics model for regional analysis. Schwarz, I.A. (Dartmouth Coll., Hanover, NH). pp 830-834 of In Modeling and simulation. Volume 7, Part 2. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P2.

A conceptual approach was developed to establish a system dynamics model for the simulation of multiregional problems. This approach permits the design of a complex disaggregated model, with the inclusion of geographical factors like location and distance, without the loss of model transparency. By coupling the generic model to a comprehensive data-base, it is possible to simulate different regions with the same model structure.

957 Development of approaches for acceptable levels of risk. Rowe, W.D. (Environmental Protection Agency, Washington, DC). pp 1061-1065 of In Modeling and simulation. Volume 7, Part 2. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P2.

The acceptability of new technology options depends upon the development of methods to establish acceptable levels of risk for society against which these options may be compared. Insight into the problems of developing acceptability criteria is provided which may lead to the development of such criteria. The purpose of the paper is to discuss some of the problems and considerations that must be taken into account when acceptable levels of risk for society are to be developed. It is more concerned with how one goes about determining acceptable levels of risk than what the outcome of such determinations might be.

ECONOMICS AND SOCIOLOGY

REFER ALSO TO CITATION(S) 957, 971, 1002, 1012, 1029, 1032

958 (DOT-TST—77-43) **Mobility of people and goods in the urban environment: mobility of the handicapped and elderly. Second year final report.** Falcocchio, J.; Santimataneedol, S.; Horwitz, L.; Stephanis, B. Sep 1976. 137p. NTIS.

An evaluation methodology for the analysis of alternative transportation improvements for the handicapped and elderly is proposed. The approach is based on the ability to incorporate the qualitative attributes of transportation systems which are particularly significant to the handicapped and elderly groups. These attributes include comfort and convenience, security and safety, and accessibility. In addition, this study addresses the issues of demonstration projects planning and offers guidelines for the design of demonstration experiments which can produce results that are capable of objective analytical interpretation.

959 Sensible substitute for the Federal income tax on utilities. Batinovich, R. **100**: No. 2, 13-17(21 Jul 1977).

Elimination of the Federal income tax for investor-owned utilities would accomplish the following: simplify the rate-making process and mitigate "regulatory lag"; restore credibility in the regulatory process; and eliminate tax incentives to construct unnecessary utility plants. Substitution of a gross-usage or gross-revenues tax for the Federal income tax would serve the following purposes: provide revenues to the Federal government; reward conservation-oriented consumers; provide a national lifeline rate and low-income residential consumers tax credits; remove the "phantom tax" income; eliminate two-for-one payments by consumers; and finance new energy supply projects. Chronological histories of the treatment of liberalized tax depreciation in California and treatment of investment

credits in California are followed. President Robert Batinovich of the California Public Utilities Commission tells why he believes that all pretense of the Federal income taxation of investor-owned utilities should be abandoned through a revision of the Internal Revenue Code exempting them from taxation. In its place, a more equitable tax in the form of a gross usage or a gross revenues tax could be levied. It should be made to fall on all utility customers alike. (MCW)

960 Investments for urban infrastructure in boomtowns. Cummings, R.G.; Mehr, A.F. (Univ. of New Mexico, Albuquerque). **17**: No. 2, 223-240(Apr 1977).

Planning for coordinated investments in community infrastructures can avoid economic and social disruptions when sudden changes lead to inadequate facilities. Analysis of a community's infrastructure can be complicated by difficulties in projecting population shifts, acquiring investment capital, and defining the optimum level for satisfying demands. A flow diagram illustrates an investment scheme based on setting community goals and criteria on the assumption that trade-offs exist. Although further research is needed before the costs and benefits of urban infrastructure can be detailed, an indirect approach is proposed for modeling a composite community with a large construction project. Results indicate that urban infrastructure can affect wage differentials, which are related to educational facilities in boom towns. Suggestions for further study on private capital expenditures, the influence of expectations on wage differentials, cost benefits for the total population, and the community's mechanism for decision making are proposed for a better understanding of urban infrastructure. (DCK)

961 Electrical energy systems. Washington, DC; Department of Commerce (1977). 135p. (NP—22278). GPO $2.00.

The Global Marketing Program is aimed at world-wide market penetration. It involves medium to long-term action by the Government in concert with 15 U.S. industrial sectors designated as target industries. This publication summarizes major foreign markets for electrical energy systems. Purchases of generation equipment in the twenty-two countries surveyed totaled nearly $9 billion in 1975 and are expected to reach $13 billion by 1979. Both developing and industrial nations have nuclear power plant construction programs aimed at reducing dependency on imported fuels. Country Market Surveys describe the market for electrical energy systems in 16 countries and briefs for 6 additional countries are provided. Each survey discusses market size, competitive environment, major end-users, and advanced technology/new sources of energy. The sixteen countries are Australia, Belgium, Brazil, Colombia, France, Germany, Indonesia, Iran, Italy, Japan, Korea, Mexico, Netherlands, Taiwan, Spain, and United Kingdom, with briefs on Ecuador, Finland, Malaysia, Nigeria, Singapore, and Yugoslavia. Marketing assistance and information, financing export sales, and export credit insurance are services available to American exporters and these are discussed. (MCW)

962 Energy use and income level: a case study of economic model development. Hanes, L.L. (Univ. of Illinois, Urbana); Rhoten, R.P. pp 756-758 of In Modeling and simulation. Volume 7, Part 2. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P2.

Before one begins the development of a model to describe the dynamic behavior of a socio-economic system, the data requirements should be carefully examined. This paper presents a case study of using input-output analysis to answer the seemingly simple question of how energy use varies as a function of family income. The procedures and results illustrate the availability and applicability of government data sources.

963 Value of energy resources: perfectly inelastic demand case. Hanson, D.A. (Ohio State Univ., Columbus). pp 869-872 of In Modeling and simulation. Volume 7, Part 2. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P2.

The value of energy resources must be tied to the cost of obtaining substitutes for them. In this paper some explicit but simple cases are presented where demand is perfectly inelastic and the expansion path for the substitute process takes place over a significant length of time.

964 Modeling new energy products: market, cost, and profit aspects. Lance, J.R. (Westinghouse Electric Corp., Pittsburgh). pp 968-973 of In Modeling and simulation. Volume 7, Part 2. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P2.

Many techniques for evaluating energy-related new product proposals and alternatives are either nonquantitative or too complex for general applications. As a result, they add little understanding, fail to aid decision making, and often reduce the effectiveness of communication. Effective modeling of new products can be achieved with simplified models that involve the business decision-maker in the model-building process. This approach has led to the development of a model that can be used for both the initial screening of new-product proposals and increasingly precise evaluations of specific products as they approach market introduction. The model links customer benefits and the potential market to the profits and costs of the new product. The model is being used to evaluate new products for the utility power generation and other industries. An example is included in the text.

965 United States energy model economically driven by a global growth simulation. Alexander, J.F. Jr.; Sipe, N.G.; Odum, H.T. (Univ. of Florida, Gainesville). pp 1013-1019 of In Modeling and simulation. Volume 7, Part 2. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P2.

Dual dynamic mini-models of the world and the United States were developed to simulate United States growth trends. The models were developed using energy language diagrams and concepts developed by H. T. Odum. The models were simulated from 1954 through 2054 using DYNAMO II simulation language. Equations, symbols, and systems diagrams are presented and explained.

966 Initial study of an economic system with energy resources constraint. Mukundan, R. (Clarkson Coll. of Tech., Potsdam, NY); Varaderajan, V. pp 1020-1025 of In Modeling and simulation. Volume 7, Part 2. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P2.

This work formulates a basic economic system for the United States, with constraints on energy resources. The sensitivity of the resource equations is examined and possible future trends in resource economics are predicted. An optimal control policy on the effective growth rate of labor is developed. The results are in good agreement with economic principles and reasoning and in addition provide a guideline for the energy policies of the future.

967 Energy conservation, employment, and the economy. New York; Scientists' Institute for Public Information (1975). 67p. (CONF-7510174—).

From Seminar on energy conservation, employment and the economy; Washington, District of Columbia, USA (Oct 1975).

The panel discussion on energy conservation, employment, and the economy was moderated by Dan W. Lufkin who stated that the specific objective of the discussion was to search for or contribute to an energy policy for the nation. Dr. Barry Commoner, the first panel speaker, spoke on Capital Implications of Unconstrained Energy Demand. Other panel discussions were: A View from Labor on Energy Conservation Policy, Irving Bluestone, UAW; Energy Management Systems and Job Conservation, Fred Dubin and Richard Aspenson, Dubin—Mindell—Bloom Associates and 3M Corporation, respectively; The Potential for Growth in Secondary Metals Recovery, Alan Amper, Steelmet; and the energy problem of New York City. (MCW)

ENVIRONMENT, HEALTH, AND SAFETY

REFER ALSO TO CITATION(S) 110, 976, 986, 1013, 1014, 1368

968 (EPA—600/2-76-212, pp 23-31) **Environmental implications of high energy use.** Levine, M.D. (Sanford Research Inst., Menlo Park, CA). Aug 1976.

From Symposium on environment and energy conservation; Denver, Colorado, USA (3 Nov 1975).

In Symposium on environment and energy conservation.

The meaning of the term "high energy growth" is discussed. Analysis of energy projections made between 1972 and 1975 reveal that the OPEC oil embargo marked a significant change in attitudes about energy growth. After the embargo, most analyses of future energy growth rates were 15 to 20 percent lower than projections made before the embargo. The relationship between energy use and the environment is discussed from two points of view: that of the

proponents of energy conservation and that of the proponents of energy growth. Analysis of the most significant adverse impacts of energy growth on the environment lead the author to advance the axiom: To the extent that high energy growth requires rapid commercialization and deployment of new and advanced energy conversion and processing technology, the probability and extent of significant environmental, health, and safety problems are greatly increased. A number of examples are presented in support of this statement.

969 (EPA—600/2-76-212, pp 75-79) **Environmental implications on nontechnological methods to conserve energy.** Gibbons, J.H. (Univ. of Tennessee, Knoxville). Aug 1976.

From Symposium on environment and energy conservation; Denver, Colorado, USA (3 Nov 1975).

In Symposium on environment and energy conservation.

U.S. policy to improve health, safety, and environment has resulted in higher energy prices, reflecting more adequately its true cost. The OPEC cartel price shift raised prices further. In response to higher prices, energy users are shifting to less-energy-intensive consumption patterns and higher efficiency of use. The environmental implications of these altered consumption patterns are generally salubrious, because the actions taken to save energy are much less-polluting than using the energy. Most other policies to induce additional conservation will not only save consumer's money but will further reduce environmental insults. There are some proposed actions to save energy by relaxing environmental controls. While a small amount of energy could be saved in this way, it seems far more productive to save energy through increased efficiency of use rather than a retreat from environmental goals.

970 (LA—6674) **Air quality and energy development in the Rocky Mountain west.** Hinman, G.; Leonard, E. Sep 1977. Contract W-7405-ENG-36. 139p. Dep. NTIS, PC A07/MF A01.

Current ambient air quality standards in the six Rocky Mountain states have been used to evaluate limits on the number of energy conversion facilities that can be constructed in nine resource areas in these states. Facilities considered were coal-fired power plants, coal gasification plants, and shale oil extraction facilities. The number of facilities determined in this way is compared to the numbers required in 1980, 2000, and 2020 according to a regionally disaggregated national scenario. The comparison shows that present air quality standards probably will not limit coal development in the Rocky Mountains severely but that extensive oil shale development will not be possible using current facility design. Pollutant dispersion calculations have also been used to approximate the air pollution impacts of full energy development on health, property, and aesthetics in the region. The impacts will be substantial but not large compared to the cost of control equipment or the regional economic benefits generated by the energy industries. The study brought out the high value of further research and development on reducing emissions from shale oil processing facilities, on better understanding of public perception of changes in visibility, and on knowledge about pollutant transport in mountainous terrain.

971 **Flue-gas desulfurization: the magnitude of the financial pressure.** Biondo, S.J. (Federal Power Commission, Washington, DC). **100**: No. 5, 18-21(1 Sep 1977).

The capital expenses facing public utilities are analyzed and the conclusion reached that the costs of adding scrubbers to meet air-quality standards does not differ significantly from the cost of burning low-sulfur coal. New coal-fired plants, required to either install flue-gas desulfurization equipment or burn western coal, will all have additional capital expenses to meet either alternative for compliance. Financial data are developed to project capital requirements for the two alternatives for the years 1977 to 1985. Scrubbers add 14 percent to the total cost of the plant and may present problems for individual utilities seeking investors. Comparisons of the average return on equity and interest coverage ratios are summarized in tables. The financial health of public utilities is not felt to be jeopardized by the new regulations. (DCK)

972 **Strict gas turbine NOx limits coming from EPA. 55**: No. 6, 62(Jun 1977).

New gas turbine installations will be given rigid air pollution standards by the Environmental Protection Agency (EPA), which will require that NOx emission be reduced an average of 70 percent to a limit of 75 parts per million. Sulfur dioxide emission standards will be set in accordance with 0.5 percent sulfur fuels. Utilities, arguing against the new standards, cite that it is impractical to require pure water injection into gas turbine combustors. If the new regulation is adopted it will preclude any other fuels than No. 2 distillate oil at a time when utilities have been moving toward residual, coal-derived, and high-sulfur fuels as alternatives. The EPA defends the water-injection concept as being well demonstrated. Tables summarize estimated emission rates for turbines of different manufacturers and list known installations using water or steam injection. (DCK)

973 **Energy production and environment.** Paris; Organisation for Economic Co-Operation and Development (1977). 106p. .

This report is intended to provide a brief review of a number of important issues, and suggested measures to deal with these issues, that arise with respect to environment protection when OECD governments seek to develop their energy policies. Although the energy policies of Member countries will differ, they can be expected to fall within the framework of the assessment given in the OECD report Energy Prospects to 1985, January 1975, (EAPA 1: 01878). The introductory chapter provides a detailed summary of that report. The chapters that follow can be considered as initial contributions to the question, to what extent it is possible to simultaneously achieve environmental protection and energy policy goals. The chapters are entitled: The Siting of Major Energy Facilities; Environmental Impacts from Offshore Exploration and Production of Oil and Gas; Major Coal-Related Environmental Problems; and Interdependence of Energy Policies and Those to Reduce Emissions of Sulfur Oxides.

974 **Energy and environment: control of gasoline, automobiles, and pollution.** Resek, R.W. (Univ. of Illinois, Urbana). pp 901-905 of In Modeling and simulation. Volume 7, Part 2. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P2.

The interaction of air pollution, energy use, and societal cost are analyzed in a framework of lead pollution. Alternative measures for control of pollution are considered for their effect on automotive efficiency, the gasoline supply-demand relation, effects on agricultural crops, and effects on human health. Results are to be developed as to time paths of future effects under alternative policies.

ENERGY RESOURCES

REFER ALSO TO CITATION(S) 963, 1010, 1040

975 (AD-A—041206) **Europe's changing energy relations. Interim report.** Mendershausen, H. Dec 1976. Contract DAHC15-67-C-0158. 124p. (R—2086-ISA). NTIS PC A06/MF A01.

In considering Western Europe's changing energy relations, this report projects likely changes and examines current developments in the energy structures of OECD-Europe and the United States, and discusses international political, economic, and security issues related to these developments and to possible emergency disruptions of international oil supply. By 1985 OECD-Europe will probably use relatively less oil and coal, and relatively more nuclear electricity and natural gas. The United States will probably use relatively more coal and nuclear electricity, relatively less natural gas, and about the same proportion of oil. The two areas' degrees of dependence on imported oil appear to be converging--Europe's remaining, however, distinctly higher. Oil will remain by far the largest single source of energy in both areas, and the 'swing fuel'. Assuring an uninterrupted flow of oil by diplomatic and military means will become to a greater extent a matter of U.S. economic self-interest.

976 **Energy and the Colorado River.** Anderson, J.C.; Keith, J.E. (Utah State Univ., Logan). **17**: No. 2, 157-168(Apr 1977).

Evidence that energy development on the Colorado River will be detrimental is not clear, although policy decisions that set economic and institutional constraints and incentives will determine where the impacts are felt. Comprehensive in-depth studies of the social, economic, and physical effects of potential water quality and allocation changes are called for. The Colorado River's diverse setting has prompted an equally diverse demand, so that opponents to energy development cite adverse impacts on local streamflows and water quality and supplies. The extent of water use from the river involves state, interstate, regional, and international water rights and agreements, which will require complex legal adjustments. Increased demand on the water could have economic implications if it results in a transfer of water use from agriculture to other uses and if upstream use increases downstream salinity. A case is drawn from energy modeling which demonstrate that nearly everyone can benefit and damage can be offset with new benefits. Water quality maintenance is shown to depend more on natural flow rate and other factors than the presence of energy facilities. (DCK)

977 **Can we get there from here.** Margolf, C.W. **66**: No. 3, 7-8, 22-23, 26-27(Mar 1976).

From Colorado Mining Association's national western mining conference; Denver, CO, USA (29 Jan 1976).

The need to shift the U.S. energy base from oil/gas to a renewable energy resource base, such as solar energy or fusion, the time schedule for this shift, the role of coal as the main energy source while the more advanced energy technologies are being

developed, and the role of environmentalists, federal agencies, U.S. Congress, and current energy policy in developing means for handling the energy crisis are discussed. (LCL)

RESEARCH AND DEVELOPMENT

REFER ALSO TO CITATION(S) 983, 991, 1026

978 Energy R and D modeling for budgetary decisions. Chen, K.; Lathrop, J.; Kirkwood, C.; Pollock, S. (Univ. of Michigan, Ann Arbor). pp 955-962 of In Modeling and simulation. Volume 7, Part 2. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P2.

A top-down approach is taken to apply multiobjective decision analysis to the strategic budgetary decisions in energy R,D and D (research, development and demonstration) planning. A model is developed for the explicit and quantitative treatment of uncertainties and project interrelationships. The model is applied to an example budgetary allocation between two coal liquefaction programs, H-Coal and Synthoil. The example demonstrates the potential appropriateness of decision analysis in energy R, D and D strategic planning.

NUCLEAR ENERGY

REFER ALSO TO CITATION(S) 225, 248, 285, 286, 298, 299, 325, 342, 354, 608, 609, 614, 671, 711, 712, 727, 731, 846, 999, 1000, 1008, 1030

979 (ORAU/IEA(O)—77-17) **Outline for an acceptable nuclear future.** Weinberg, A.M. Jul 1977. Contract EY-76-C-05-0033. 26p. Dep. NTIS, PC A03/MF A01.

Nuclear energy is likely to develop in two phases. Phase I, based on burner reactors, is self-limiting because the reserve of uranium is limited. Phase II, based on breeders, might last for an extremely long time. It is suggested that opposition to Phase I of nuclear energy might be reduced if an acceptable Phase II can be constructed. Elements of an acceptable Phase II might include isolated and collocated energy centers with resident IAEA inspectors; heavier security; professionalization of the nuclear cadre; immortality of the operating entities; and separation of generation and distribution. Though these measures are aimed primarily at increasing the safety and reliability of the nuclear system, it is suggested that the proposed siting policy, with IAEA resident inspection, might be more proliferation-resistant than is the current dispersed system.

980 Turkey looks to nuclear energy to keep pace with demand. Cetelincelik, M. **14**: No. 9, 27-30, 41(Sep 1977).

Although Turkey is currently meeting her energy requirements, rapid industrialization and growth in electrical demand indicate a need for nuclear power plants with a total capacity of 6000 MW by the year 2000. The economic growth has also been accompanied by urbanization and a higher per capita energy consumption. A review of energy consumption from 1950 and projections to the year 2000 show that commercial electrical growth will be more rapid than commercial energy growth. Natural resources (exploitable and possible) include one deposit of carboniferous coal, lignite, oil, and a high hydroelectric potential. Preliminary geological surveys have been made to locate uranium, thorium, and geothermal sites. Turkey is designing an energy development program that emphasizes indigenous sources, fuel efficiency, multipurpose projects, exploitation of hydroelectric and lignite sources, and the introduction of nuclear power systems. A primary aim is to minimize the dependence on imported fuels. (DCK)

981 Nuclear issues: weighing the pros and cons. Pon, G.A. (Atomic Energy of Canada Ltd., Mississauga, Ont.). **19**: No. 8, 25-28(Aug 1977).

Some of the controversial issues over radioactivity release, accident potential, security, waste management, and plutonium are reviewed in terms of weighing potential and existing risks of nuclear energy against the benefits. Many areas in Canada have found uranium fuel to be competitive and more readily available than other energy sources. Comparisons of nuclear and coal-fired plants over a 30-year service life in Ontario indicate that, while nuclear plants have a higher capital cost per kilowatt-hour, the annual fuel cost is much lower. The report concludes that the benefits far outweigh the risks in the use of nuclear energy. (DCK)

982 Second Fox Report. 4: No. 5, 7-16(May 1977).

The Federal government of Australia is showing signs of promptly giving the go-ahead for uranium development and export following the release of the second Fox Report. The major concern, though, is the details of timing and methods of development and marketing. Whether the government will accept the Fox recommendations on sequential development, allowing the Ranger project to proceed first, or whether it will allow coordinated development with Pancontinental and Queensland mines proceeding at the same or similar time as Ranger is the big question. The four recommendations that relate directly to development say that the original Ranger proposal should not proceed; but that it could proceed if the conditions laid down in the report are followed to the letter; that the Noranda mine should not proceed for the time being; and that if Ranger goes ahead, no other mining west of the Arnhem Land reserve should proceed with the possible exception of Pancontinental. The summary of conclusions is reported in this paper on these conflicting proposals. The initial reaction at the news conference is also covered in this article. (MCW)

983 Naval Nuclear Propulsion Program: 1977. Hearing on H.R. 6566, ERDA authorization legislation (national security programs) for Fiscal Year 1978 before the Committee on Armed Services, House of Representatives, Ninety-Fifth Congress, First Session, April 27, 1977. Washington, DC; Committee on Armed Services (1977). 164p. GPO.

Unclassified hearings were held on the authorization of 1978 ERDA programs for naval reactor development as a supplement to testimony Admiral Rickover gave in executive session. Admiral Rickover's unclassified testimony is followed by questions from the committee on the Navy's frequent changes of plans. He cited problems of conforming to the needs of the Defense Department and the Office of Management and Budget, which do not always agree on the need for nuclear power. He also criticized the lack of a shipbuilding program and stressed the need for a long-term research commitment. Slower speeds of surface ships are felt to indicate the need for using submarines in anti-submarine warfare. Other questions covered the new global aspects of the Soviet Navy, the CVN-71 reactor plant, commercialization of naval technology, and nuclear safety. (DCK)

984 Survey II of public and leadership attitudes toward nuclear power development in the United States. New York; Ebasco Services Inc. (1976). 184p. (NP—22283).

In August 1975, Ebasco Services Incorporated released results of a survey conducted by Louis Harris and Associates, Inc. to determine attitudes of the American public and its leaders toward nuclear power development in the U.S. Results showed, among other things, that the public favored building nuclear power plants; that they believed we have an energy shortage that will not go away soon; that they were not willing to make environmental sacrifices; and that, while favoring nuclear power development, they also had concerns about some aspects of nuclear power. Except for the environmental group, the leadership group felt the same way the public does. A follow-up survey was made in July 1976 to measure any shifts in attitudes. Survey II showed that one of the real worries that remains with the American public is the shortage of energy; additionally, the public and the leaders are concerned about the U.S. dependence on imported oil. With exception of the environmentalists, the public and its leaders support a host of measures to build energy sources, including: solar and oil shale development; speeding up the Alaskan pipeline; speeding up off-shore drilling; and building nuclear power plants. The public continues to be unwilling to sacrifice the environment. There is less conviction on the part of the public that electric power will be in short supply over the next decade. The public believes the days of heavy dependence on oil or hydroelectric power are coming to an end. By a margin of 3 to 1, the public favors building more nuclear power plants in the U.S., but some concerns about the risks have not dissipated. Even though the public is worried about radioactivity escaping into the atmosphere, they consider nuclear power generation more safe than unsafe. (MCW)

WASTE HEAT UTILIZATION

REFER ALSO TO CITATION(S) 989

CONSERVATION

REFER ALSO TO CITATION(S) 967, 1021, 1023, 1038, 1068, 1073, 1083

985 (EPA—600/2-76-212, pp 4-12) **Energy conservation policy and overview.** Bakke, D.W. (Federal Energy Administration, Washington, DC). Aug 1976.

From Symposium on environment and energy conservation; Denver, Colorado, USA (3 Nov 1975).

In Symposium on environment and energy conservation.

Conservation is the cost-effective substitution of capital, time, or labor for energy consumption. The overall potential for energy conservation, using existing technology, is enormous. Because conservation is in the economic self-interest of all energy users, a large portion of the potential will be achieved without further Federal intervention. Nevertheless, the Federal Energy Administration (FEA) estimates that additional savings of about 7.5 million barrels per day are achievable by 1985. Without the enactment of pending legislation and the expansion of existing programs, however, only about half of the potential savings in 1985 is likely to be realized. By comparing the cost of such conservation measures as installing insulation and storm windows or manufacturing more fuel-efficient automobiles to the cost of increasing energy supplies, it is clear that conservation is our cheapest future "source" of energy. There have been numerous proposals to accelerate the Federal energy conservation effort, which has up to now been constrained by limited funding and authority. But, unfortunately, the Administration and Congress remain deadlocked on many key issues. Hopefully, these issues can soon be resolved, enabling us to stop talking about the problem and begin concentrating on solving it.

986 (EPA—600/2-76-212, pp 32-47) **Implications of a national conservation strategy.** Woodcock, K.R. (Federal Energy Administration, Washington, DC). Aug 1976.

From Symposium on environment and energy conservation; Denver, Colorado, USA (3 Nov 1975).

In Symposium on environment and energy conservation.

Under the National Environmental Policy Act, the Federal Energy Administration has the responsibility to assess the environmental implications of energy conservation policies, programs, and legislative proposals. Through the use of two analytic systems, PIES and MERES, the environmental impact analysis is based directly upon the projected energy impacts of proposed programs or policies. Furthermore, the economic implications of energy strategies are assessed for the preparation of inflation impact statements. This methodology and its use in the assessment of alternative energy conservation programs and proposals are discribed. Three types of conservation strategies are discussed: energy-pricing strategies, sector-specific strategies, and combined strategies. Analytical results are presented and compared from legislative environmental impact statements prepared for the Energy Independence Act of 1975 and the Mandatory Oil Import Program.

987 **Regional land-use and energy modeling system.** Carroll, T.O.; Kydes, A.S.; Sanborn, J.B. (Brookhaven National Lab., Upton, NY). pp 1035-1040 of In Modeling and simulation. Volume 7, Part 2. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P2.

The task of searching for and selecting strategies and measures which will bring about energy conservation vis-a-vis land use becomes that of understanding and defining the relationships between sets of possible land use activities in a given region and the resultant energy end-use demand. The outcome of the search is the determination of the relative impact of such strategies and measures upon both the regional and national energy systems. In this paper a brief review of an overall approach and results to date are presented. The land-use energy utilization model currently being used is discussed.

988 **Energy conservation policy for the U.S.: five years in formulation.** Grundy, R.D. (Senate Committee on Energy and Natural Resources, Washington, DC). **47**: No. 9, 16-19(Sep 1977).

Energy conservation policy, which has evolved after five years of legislation deliberation over questions of efficiency, self-sufficiency, and the appropriate role of government, focuses on the cost analysis of lifetime energy use. Inefficiency characterizes U.S. energy problems because demand growth was designed into consumer products and rate structures. A re-evaluation of consumption patterns concludes that we must shift to technologies that allow us to accomplish comparable economic activities with less energy. Legislation setting both mandatory and voluntary efficiency standards for industry, buildings, and automobiles will challenge engineers. The discussion covers the purposes and impacts of the Energy Policy and Conservation Act, the Energy Supply and Environmental Coordination Act, the Energy Conservation and Production Act, and the Natural Energy Plan. (DCK)

989 **Increased energy efficiency in manufacturing: what can be done.** Gyftopoulos, E.P. (Massachusetts Inst. of Tech., Cambridge); Hatsopoulos, G.N.; Widmer, T.F. **47**: No. 9, 20-23(Sep 1977).

There is a firm technical and economic basis for achieving the same activities at a lower energy cost by reoptimizing manufacturing processes to improve efficiency. The utilization of known technology for this purpose would cost about $35 billion less than if new equivalent fuel supplies are developed. Investments in known technology can realize short-term improvements in the thermodynamic efficiency of the manufacturing sector, which operates at an average 13 percent efficiency. Industrial housekeeping and conservation programs can save an average of 22 percent with acceptable capital investment. Major manufacturing inefficiencies are associated with high-grade waste heat, and inherent process inefficiencies. Incentives to pursue higher efficiency require an energy policy that focuses energy-intensive steam raising and drying processes. Initiatives require that energy prices exceed replacement costs; the rate of return on investment must be competitive, and Federal, state, and local regulations must encourage cogeneration. (DCK)

990 **Federal bureaucracy has no magic wands for energy saving in buildings.** Pellish, D. (Energy Research and Development Administration, Washington, DC). **47**: No. 9, 45-48(Sep 1977).

To gain the understanding and cooperation of local governments and industry, Federal and state agencies need to hold a series of discussions to explain new energy-related codes and standards. A number of misconceptions have developed over the new regulations because of the wide applications and the variations in building codes. Several improvements in code administration that would promote better understanding and more efficient management are outlined. The Federal government is urged to help by setting an orderly, comprehensible framework that provides financial assistance and encourages innovative techniques. Three proposals for standards have been submitted by the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE), The Model Code for Energy Conservation in New Building Construction, and Title III performance standards of the Energy Conservation and Production Act. The confusion that has developed because of the array of standards (some mandatory and some voluntary) could be corrected by discussion. (DCK)

991 **Victoria's Green Paper on energy emphasises: conservation and research.** **4**: No. 3, 25-28(Mar 1977).

The major themes of the Victorian Government Green Paper on Energy are conservation and research. Although this is basically a development of present policies of the Victorian authorities, the Green Paper presents a strong case supporting conservation of all energy resources together with the maximum encouragement of brown coal based on Victoria's almost certain dependence on brown-coal-based energy in the long term. Although Victoria is relatively more fortunate in energy resources than other States, production of the Green Paper and other action by the Victorian Government distinguishes Victoria as the least complacent of Australian Governments, State or Federal, in matters of energy policy. Some of the measures canvassed by the Green Paper--such as those aimed at lifting energy price nearer to replacement costs and higher costs for motorists--will not be electorally popular. However, Victoria is further ahead than other Governments in promoting public energy awareness and in establishing parliamentary, official, and non-government sources of advice to assist in formulating broadly-based policies. The Paper is in two parts: Part One was originally presented to the Victorian Parliament in December 1974 and has been updated to 30 June 1976. Part Two outlines and assesses a future energy policy for Victoria for the years up to 2006. An Appendix containing background information and data used in preparing the Paper is published separately. A summary of the Paper is presented in this publication.

992 **Status of Federal energy conservation programs. Part 1. Hearing before the Committee on Energy and Natural Resources, United States Senate, Ninety-Fifth Congress, First Session on the progress achieved by Federal programs aimed at increasing the efficiency of energy use in the United States and the potential for further improvements in energy efficiency through additional legislation.** Washington, DC; Committee on Energy and Natural Resources (1977). 284p. GPO.

This hearing before the Subcommittee on Energy Conservation and Regulation was organized in anticipation of President Carter's energy conservation ideas in his proposed April 20, 1977 energy address. The hearing was specifically held to learn of the ideas from the public sector, but statements were also heard from some Cabinet personnel. Statements with supporting data are included from Dr. Barry Commoner, Washington University, St. Louis, Mo.; Gary DeLoss, Public Interest Research Group; Dr. John Gibbons, University of Tennessee; Dr. R. Eugene Goodson, Purdue University; Denis Hayes, Worldwatch Institute, Washington, D.C.; Dr. Eric Hirst, Oak Ridge National Laboratory; Senator Henry M. Jackson, Washington; Sen. J. Bennett Johnston, Louisiana; Dr. Henry A. Kissenger, Alliance to Save Energy; Max Ladt, Paducah Kentucky professional engineer; Glenn E. Watts, Communication Workers of America; Macauley Whiting, Dow Chemical Company; and Dr. Robert H. Williams, Princeton University. (MCW)

993 Scenario for reduced energy use and conservation in the United States: 1975—2050. Steinhart, J.; Kabala, S.; Hansen, M.; Thornsjo, M.; Gates, R.; Briody, K.; DeWinkel, C. Madison, WI; University of Wisconsin (1977). 54p. (CONF-770210—10).

From A.A. advancement of science conference; Denver, Colorado, United States of America (USA) (20 Feb 1977).

The low-energy-use scenario outlined in this paper is an estimate of the lowest energy use future that the authors consider plausible. The plausibility criterion is applied by eliminating those possible futures that require technological miracles, dramatic changes in human behavior, or complete restructuring of national and/or world political groupings. The results estimate more than a 60 percent reduction in U.S. energy use from 1975 levels to be obtained a few decades into the 21st century (less than 75 years from now). An attempt is made to incorporate and extrapolate demographic and settlement relocation trends and to identify some other private trends that might be usefully encouraged. The legislative measures discussed have been proposed at state or Federal levels already, though some may be far from enactment at present. The changes of life style implicit in this scenario blends present trends with subjective estimates of how far they might proceed. Some of the economic and employment implications of the scenario are pointed out. Quantitative economic analysis is not attempted because such analysis is very sensitive to the projections of future discount rates and future fuel price increases. Plausible (and published) estimates of these two variables differ sufficiently to produce net discount rates for energy costs (rates of deflated energy cost increase minus discount rate) which are either positive or negative. Resolution of these differences requires at least some agreement about the quantitative role of energy price increase in general inflationary pressures. These relationships, at present, are in dispute. This scenario is not proposed as a plan. It is offered as one of the growing number of such possibilities in the hope that the area of public discussion may be enlarged. 46 references.

994 Minnesota Alternative Energy Research and Development Policy Formulation Project. Minneapolis; Architectural Alliance (1977). vp. (NP—22272).

After a brief review of climatically oriented cultures (specifically, the Pakistani "bad-gir" and underground living in the Loess Belt of China), the built environment in Minnesota is considered. Studies are cited in this paper where energy consumed in the Minnesota built environment can be reduced by one-half to two-thirds in new construction and by one-third in existing buildings by utilizing known energy conservation measures. By combining good energy conservation measures and solar energy in newly constructed buildings, the total energy consumed need be only 10 to 25 percent of that used by conventional buildings. Recommendations made in this study include: a series of demonstration programs to provide a mechanism for observation and to stimulate interest; change Federal and state laws to encourage energy conservation; disseminate public information; and conduct some formal technical research. 36 references. (MCW)

995 Energy management. Smith, C.B. Santa Monica, CA; Applied Nucleonics Company, Inc. (1976). 17p. (CONF-7610127—1).

From American Public Power Association Services and Communications Section workshop; San Francisco, California, USA (20 Oct 1976).

In the face of diminishing natural resources and a worldwide increase in demand for energy, efficient use of energy must be practiced—in the home, on the farm, in industry, and in the cities. Three basic approaches that can be used to reduce the quantity of energy are self-denial and regulation or economic pressures; increasing efficiency by better housekeeping and operational procedures, applying more-efficient equipment, and using different materials; and substituting other energy forms. The elements of an energy management program described are initiation phase, audit and analysis phase, and implementation phase. Some time data, complexity, and benefits are charted for these elements. Examples that are used to describe the process include: heat recovery using air preheater and wise air heating and compressor cooling cycle. (MCW)

SUPPLY, DEMAND, AND FORECASTING

REFER ALSO TO CITATION(S) 954, 980, 1012, 1025, 1028, 1075

996 (ORNL/TM—5890/S1) Energy availabilities for state and local development: 1972 data volume. Vogt, D.P.; Rice, P.L.; Pal, V.P. Sep 1977. Contract W-7405-ENG-26. 264p. Dep. NTIS, PC A12/MF A01.

Following a brief overview of the methodology and data sources, this report presents the supply, demand, and net imports of seven fuel types for four final consuming sectors of BEAs, states, census regions, and the nation in 1972. The data are formatted to distinguish the regional energy availability from primary extraction and that from regional transformation processes. As constructed, the tables depict energy balances between availability and use for each of the specific fuels. The project was sponsored by the Economic Development Administration to pinpoint those regions that are most likely to be affected by significant changes in energy delivery and consumption patterns, such as increased natural gas curtailments. This information coupled with specific knowledge of projected economic growth and employment distribution patterns can assist EDA in developing its grant-in-aid investment strategy.

997 Energy profile of Iran. 14: No. 9, 33-41(Sep 1977).

Iran, aware that oil reserves are running out as domestic and foreign demands increase, is seeking an industrial base capable of producing exports that can generate revenues comparable to those of oil. Unlike other Arab nations, Iranians have developed a professional class of entrepreneurs and engineers, although widespread technical skills have not been developed. The sixth in a series of five-year plans will go into effect on March 21, 1978. Electric utilities were nationalized in 1964 in a system, modeled after the British, of a centralized generating board (Tavanir) and regional boards for distribution and sales. The role of private industrial generating plants for plant electricity and process steam has declined since then; but when recent demand outpaced the capacity of public systems, controls were relaxed. An overview of the electrical supply and demand situation focuses on the status of Tehran, which has experienced the largest load growth coupled with manpower and equipment shortages as well as environmental contraints on energy development. A nuclear power plant, the first in a planned national grid, will begin operating in the early 1980s. Development plans for the nuclear generating program are outlined. (DCK)

998 New Zealand examines options as energy crisis looms. Scott, W.E. **14**: No. 9, 53-56(Sep 1977).

New Zealand is counting on a reorganization that combines three energy departments to coordinate planning and expedite development of badly needed resources for power generation. The new Ministry of Energy will retain most of the three departments' experts, but will combine some personnel from each in a power generation division. A 600-MW power station commissioned at New Plymouth will be New Zealand's largest thermal power plant until the 1000-MW Huntly station is finished in 1980. Originally designed to burn coal, the New Plymouth station was modified to burn fuel oil and natural gas when the Mauri gas fields were discovered. Hydroelectric power is currently used to generate 77 percent of the country's electricity, with geothermal furnishing 6 percent. After reassessment of energy options, the Ministry set a policy of using indigenous coal and gas to accommodate the expanding demand for power. Future energy development will require development of geothermal, solar, and other unconventional sources. Projections of an annual 7 percent energy growth rate over a 15-year period are needed to meet electrical demand. The assessment concluded that the coal will be insufficient as a long-term primary energy source, and natural gas will be used until the first nuclear station is operating at the end of the century. Consideration of appropriate end uses must be given when decisions are made to allocate limited resources to power generation. (DCK)

999 Energy: a conservative view. King, T. No. 13, 3-9(Sum 1977).

The Parliamentary shadow spokesman for energy urges the Government not to commit itself to an inflexible vision of the future energy scene. At present, Britain has more fuel options than many other countries and they should be kept open. The interim period of energy abundance means, however, that the necessary measures to offset the subsequent 'energy gap' will be unpopular and, following President Carter's example, the energy saving programme should be co-ordinated from the top. Coal and nuclear power must be developed to take the strain when oil and gas run out, but meanwhile the balance of payment benefits of oil and gas buy time to develop the technologies to carry us beyond the 1980s.

1000 Planning for shortage in the midst of plenty. Tombs, F. No. 13, 25-32(Sum 1977).

In this article Mr. Tombs, who succeeded Sir Peter Menzies as Chairman of the Electricity Council in April, describes the problems of investing during a period of self-sufficiency to avoid an energy crisis at the end of the century. Warning against complacency in the "fat" years, he asserts the need for very substantial additional investment in all the energy industries and for a major contribution from non-fossil fuel sources, notably nuclear energy. Otherwise, he says, the resultant crisis will be far worse than any yet experienced and could result in a dramatic lowering of living standards.

1001 Current outlook for energy fuels. Wilson, W.W. Chicago; Continental Illinois National Bank and Trust Company (1976). 17p. (CONF-7606158—1).

From 22. annual educational seminar; Milwaukee, Wisconsin, USA (22 Jun 1976).

The author reviews the impacts on the natural gas industry from 1938, when the Natural Gas Act was passed, to the present. He points out that control of interstate sales of natural gas impacted the coal and petroleum markets. Coal output slid from 501 million tons in 1956 to 403 million tons in 1961; coal prices flattened and remained unchanged from 1956 to 1970. In 1956 more than 57,000 wells were drilled by the domestic petroleum industry, the largest number in its history. Thereafter, all of oil's important statistics slid into a prolonged decline that continued for the next 15 years. Crude oil prices remained flat even though costs of all kinds rose as much as 20 to 70 percent. Capital for reinvestment failed to keep pace with the depletion of developed reserves, domestic exploration was cut back and many companies were attracted to overseas operations because of more attractive rates of return. Legislation in the seventies is reviewed and an analysis of the threat of divestiture of the oil companies is made. In the discussion on American thriftiness, the author cites examples where the energy saved is ever so slight. He strongly advocates a new energy policy calling for increased supply along with energy conservation. The old energy policy failed because it encouraged consumption and discouraged expansion of our domestic sources of supply. A prompt restoration of a free market for all types of energy fuels is needed, he says. (MCW)

1002 Long-run economic and energetic model for an industrial country. Camino, F.M. (CNRS, Toulouse). pp 898-900 of In Modeling and simulation. Volume 7, Part 2. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P2.

A long-run model of the economic and energetic behaviour of an industrialized nation, France in this case, is developed, with the aim of giving a tool for decision making and assessment of economic and energetic policies to the central authorities, and this through the solution of optimal allocation problems. The model is composed of three interacting sub-models: a national macroeconomic model, a model of the energy sector, and a model of the environment, corresponding respectively to demand of energy, supply, and environmental constraints.

1003 International energy demand model: twenty OECD country models. Cato, D.; Reiser, E. (Federal Energy Administration, Washington, DC). pp 923-928 of In Modeling and simulation. Volume 7, Part 2. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P2.

An energy demand model is described that forecasts energy demand for 20 OECD countries. As a group, these countries historically have consumed 40% of world energy and thereby are important in determining the world's future energy requirements. The primary focus of this paper is on model structure, estimates, and performance. Since energy price and income are exogenous, various scenarios could be developed for policy analysis; however, no forecasts are presented. Demand in the framework of this paper represents demand for final products as opposed to demand for primary products. The first section describes product, sector, and country details. This section is followed by a discussion of the model structure, which differs by sector, and elasticity relationships. The final two sections consider the model's estimate and statistics and performance. The final user sectors are divided into six sectors: Transportation, Manufacturing, Residential and Commercial, Other Petroleum, Non-Energy Petroleum, and an Energy Sector. (MCW)

1004 International energy evaluation system. Pearson, J.D.; Edwards, S.W.; Everett, C.; Kilgore, W.C.; Tukenmez, E. (Federal Energy Administration, Washington, DC). pp 929-936 of In Modeling and simulation. Volume 7, Part 2. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P2.

From time to time the Federal government is required to analyze the impact of various national and international policies on the energy flows into and around the U.S. and its allies. Those policies include such questions as the effect of embargoes, import tariffs or quotas, LNG shipment policies, and a number of similar issues. To assist in this policy analysis, FEA constructed a detailed simulation of equilibrium energy flows for a typical day of a year in the range 1975 to 1985. The simulation forecasts supply and the derived demand for primary energy forms--coal, natural gas, crude oil, under the assumption that once OPEC has set a world oil price the price mechanism will equilibrate non-OPEC supply and world demand in the snapshot year. The IEES model consists of several submodels linked together into a complete analytical system. The demand model calculates final consumption demands for refined petroleum products, coal, natural gas, and electricity, as functions of energy prices, given the input macroeconomic and demographic assumptions. The supply models calculate supplies of primary energy materials (coal, petroleum, natural gas) as functions of the prices of these resources. The conversion technology models represent petroleum refining and electrical generation activities; these models provide links between primary material supplies and product demands. The transportation model describes the transportation of primary materials and refined products among the various regions represented in the system. Finally, the market-clearing mechanism calculates the prices that equate supply and demand simultaneously in each market. (MCW)

1005 Energy supply planning model: a working tool for regional analysis of alternative national energy policies. Carasso, M.; Gallagher, J.M. (Bechtel Corp., San Francisco). pp 1041-1048 of In Modeling and simulation. Volume 7, Part 2. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P2.

The model was designed to provide a quantitative tool useful for analysis of feasibility of candidate national energy policies in the 1975-1995 time frame and in their regional implications. This capability is provided by simulating the capital, labor, materials, and industrial production capacity requirements associated with construction and operation of energy-supply and energy-transportation facilities needed to implement alternative energy policies. The model simulates a highly disaggregated U.S. energy-supply system including 91 types of energy extraction, processing, and transportation facilities. It determines the requirements for approximately 75 categories of capital, manpower, materials, and equipment for each region and for the nation as a whole, based on a data base containing these requirements for each facility simulated. This model combines the development of an extensive current industrial data base and its organization into a framework that permits the policy maker flexibility to test the sensitivity of total regional and national societal resource requirements to changes in national and regional energy-policy variables. Its determination of region-specific facility schedules is useful for the evaluation of environmental implications of energy policies. The model is being used as an energy poiicy and regional impacts analysis tool by several organizations; it is publicly available.

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 952, 959, 972, 973, 977, 983, 988, 989, 990, 992, 994, 1001, 1005, 1018, 1028

1006 (CONF-760838—, pp 12p, Paper 16) **Overview of the U.S. energy dilemma.** Stokes, C.A. (Stokes Consulting Group, Princeton, NJ). 1976.

From 3. annual international conference on coal gasification and liquefaction; Pittsburgh, Pennsylvania, United States of America (USA) (3 Aug 1976).

In 3rd international conference on coal gasification and liquefaction.

With the very few approaches described, we could develop enough coal use to exceed our ability to produce the coal. We don't need to make synthetic crude oil or gasoline out of coal right now, or to make vast amounts of methane in order to solve our major problem, which is to reduce crude oil importation with its consequent strains on our security and solvency. We only need to burn coal directly to make steam, to gasify coal for industry's critical fuel and feedstock needs and to make a low-S, low-ash boiler fuel from coal with methanol and/or high-pressure synthesis gas and/or industrial fuel gas as a co-product to use the dregs of the liquefied barrel of coal. The other objectives of motor fuel and methane are very worthy of development, but large-scale commercial production is another matter. We may need them eventually, and we should have the best possible technology to do it. But, right now, we must concentrate on a few reasonable, attainable commercial objectives, and get on with accomplishing these commercially, not just forever talking and researching while the taxi meter of inflation ticks away at 5 or 6% per year or more. Even these recommendations cannot be carried out by a financially responsible company unless oil and natural gas prices are decontrolled or the projects are subsidized.

1007 (EPA—600/2-76-212, pp 48-50) **Legislative programs in energy conservation.** Savitz, M.L. (Energy Research and Development Administration, Washington, DC). Aug 1976.

From Symposium on environment and energy conservation; Denver, Colorado, USA (3 Nov 1975).

In Symposium on environment and energy conservation.

As part of the President's overall energy program, four legislative initiatives were submitted to Congress in 1975. The Energy Independence Act of 1975 contained three of these actions: Title X, Building Energy Conservation Standards Act of 1975, which would establish national thermal efficiency building standards for all new buildings to be implemented by States and local governments; Title XI, Winterization Assistance Act of 1975, which would provide States with funds to help purchase energy conserving materials to be installed in homes owned or occupied by low-income families; Title XII, National Appliance and Motor Vehicle Energy Labeling Act of 1975, which would require labeling of energy consuming major appliances. In addition, the President requested Congress to enact legislation that would amend the Internal Revenue Code to provide individuals with a tax credit for 15 percent of the cost of modifying their homes to conserve energy. In addition, other legislative options for achieving energy conservation in buildings and industry have been proposed by the members of Congress. The status and implication of the various legislative activities will be discussed.

1008 Farewell interview with NRC Chairman Rowden. Hill, R.L. **100**: No. 1, 24-28(7 Jul 1977).

Marcus Rowden, former chairman, shares his concerns for the future of the Nuclear Regulatory Commission under the new Department of Energy (DOE). He is hopeful that a constructive relationship between the two will allow nuclear development to proceed efficiently, but with the independent regulation needed to reassure public fears. He stresses the need for regional planning and licensing reform that will improve the licensing process. Risk assessments need to be made that are relative to the risks of other energy sources. Decisions on nuclear waste disposal and power plant security are national in scope and should be made by a single body which has listened to all points of view. Resignations over regulatory decisions indicate that the system is neither perfect nor monolithic, but allows dissenting voices to be heard. (DCK)

1009 Federal role in Rocky Mountain energy development. Plummer, J.L. (National Science Foundation, Washington, DC). **17**: No. 2, 241-260(Apr 1977).

Interactions between the Federal and State governments over coal and synthetic fuel policies for the Rocky Mountain area are described, with attention drawn to strategic points that may have been misunderstood. A review of both actual and potential areas of conflict illustrates the complexity of issues involved in confrontations between State and Federal interests that have produced tension and anxiety among the residents. Federal policies directly affecting the area include coal leasing, reclamation of strip-mined land, and the use of eminent domain to build coal slurry pipelines. Indirect effects will be felt from policies on air quality, energy facility siting, resource taxation, and financial incentives for resource development. Conflict with Federal legislation has prompted some states to develop their own legislation, which must now be implemented if the states intend to avoid Federal domination. Both State and Federal agencies are understaffed, providing the states with an opportunity to fund expansion and improvement in their offices. Over-simplifying the controversy can be avoided by expanding the information exchange between the two levels of government and increasing the amount of available data on socio-economic impacts of resource development. (DCK)

1010 Public Works for Water and Power Development and Energy Research Appropriation Bill, 1978. Report submitted to the 95th Congress, First Session to accompany H.R. 7553. Washington, DC; Committee on Appropriations (1977). 109p. GPO.

This publication is a report to the Senate by the Committee on Appropriations regarding the bill H.R. 7553, which provides appropriations for public works for water and power development and energy research for the fiscal year ending September 30, 1978. It provides funds for the Energy Research and Development Administration (except for Fossil Fuel and certain conservation programs) in Title I; for water resources development programs (including power) and related activities of the Department of the Army, Civil Functions--Army Corps of Engineers' Civil Works Program and the Department of the Interior's Bureau of Reclamation and power agencies in Titles II and III, respectively; and for related independent agencies and commissions, including the Appalachian Regional Commission and Appalachian Regional Development Programs, the Federal Power Commission, the Nuclear Regulatory Commission, the Tennessee Valley Authority, the Water Resources Council in Title IV. The bill recommended by the Committee which this report accompanies provides a total of $10,382,169,000 in new budget (obligational) authority. This is $195,423,000 more than the total of $10,186,746,000 passed by the House and $14,058,000 over the budget estimates of $10,368,111,000 submitted by the President. In subsequent budget recommendations to the Congress last February, the President initiated a review of ongoing water resource projects. After this review, the President announced on April 18, 1977 his decisions on Federal water resource programs and his specific decisions and recommendations on the 32 water projects which were subject to his review. Included in these specific decisions and recommendations were the deletion of funds for 18 projects, modification of 5 projects, and continuation of 9 projects. (MCW)

1011 National Energy Act. Report of the Ad Hoc Committee on Energy, U.S. House of Representatives, Ninety-Fifth Congress, First Session on H.R. 8444. Volume II. Appendix. Washington, DC; Ad Hoc Committee on Energy (1977). 379p. GPO.

This publication is an Appendix containing reports by five committees on energy bills. On the National Weatherization Act (H.R. 7893), Mr. Reuss, from the Committee on Banking, Finance, and Urban Affairs submitted a report, together with some supplemental views (including cost estimate of the Congressional Budget Office) on weatherization of dwelling units. The next report from the Committee on Public Works and Transportation, dealt with the National Energy Act (H.R. 6831). Mr. Johnson of California submitted the report which also included the cost estimate of the Congressional Budget office. This committee recommended some amendments to the National Energy Act. Mr. Jack Brooks from the Committee on Government operations submitted its report on the National Energy Act (H.R. 6831) with dissenting views. The report of the Committee on Ways and Means, together with supplemental, additional, minority, and additional minority views on Title II of H.P. 6831, Energy Tax Act of 1977, is included. The amendments made by this committee, with Chairman Ullman submitting the report, on the bill to provide for an energy tax policy to encourage energy conservation and conversion to alternate energy sources are reported. The last committee report with Mr. Staggers from the Committee on Interstate and Foreign Commerce submitting it, concerned the minority, additional, and supplemental views on the National Energy Act (H.R. 6831). (MCW)

1012 Political and economic factors governing access to energy in the decades ahead. Hearing before the Committee on Interior and Insular Affairs, United States Senate, Ninety-Fifth Congress, First Session on the geopolitics of energy, February 1, 1977. Washington, DC; Committee on Interior and Insular Affairs (1977). 41p. GPO.

The impact of recent U.S. dependence on oil and other energy imports was examined to see how U.S. relationships with producing and consuming nations have changed. The principal witness was Melvin A. Conant, who stressed the historical and economic complexity of energy access and the inadequate understanding on the part of the government, public, and oil companies. Mr. Conant's recommendations include: (1) vigorous efforts to develop alternative energy sources, (2) an initiative by the U.S. to develop a strategic reserve program while retaining emergency supply authority in the International Energy Agency, (3) a strategic watch over the control of tankers, (4) positive participation in the north-south dialog, and (5) a more cautious effort toward energy development in the Soviet Union. He expressed concern that potential energy conservation results may have been oversold, but that a mobilization of public effort is needed. (DCK)

1013 Simulation of multiple interests in energy environment systems. I. Methodology. Saaty, T.L.; Blair, P.D.; Ma, F.S. (Univ. of Pennsylvania, Philadelphia). pp 980-985 of In Modeling and simulation. Volume 7, Part 2. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P2.

A new approach to energy policy analysis is developed by structuring the interactive dynamic processes in energy environment systems. The future of an energy environment system is influenced by the decisions of a number of policy makers with differing interests and objectives. Current energy system modeling efforts do not effectively account for multiple interests and the interaction of policy makers. However, this interactive process can be captured in a gaming environment. This paper presents a methodology formalizing, within the framework of hierarchical systems, operational gaming for policy analysis. In a companion paper (Part II) this methodology is applied to the design of Regional Energy Environment Games (REEG). Consideration is given to extending the application to large-scale games for policy analysis. 35 references.

1014 Simulation of multiple interests in energy environment systems. II. Application. Saaty, T.L.; Blair, P.D.; Ma, F.S. (Univ. of Pennsylvania, Philadelphia). pp 986-990 of In Modeling and simulation. Volume 7, Part 2. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P2.

A companion paper (Part I) presents a methodology formalizing, within the framework of hierarchical systems, operational gaming for policy analysis. This paper applies the methodology to

the design of Regional Energy Environment Games (REEG). Consideration is given to extending the application to large-scale games for policy analysis. The study demonstrates the feasibility of large-scale energy environment games thus providing a useful tool for policy analysis. 22 references.

FOSSIL FUELS

REFER ALSO TO CITATION(S) 970, 1001, 1006

COAL

REFER ALSO TO CITATION(S) 49, 71, 977, 978, 1019, 1035

1015 (FEA/G—77/306) **Western Coal Development Monitoring System. Summer quarter.** 1 Aug 1977. 29p. Energy Administration, Washington, DC.

The Western Coal Development Monitoring system provides FEA with a means to track the progress of all existing or potential coal mines over 200 thousand tons annual production in the western United States. The system was developed in response to FEA Coal Initiative IV. The system identifies current production levels, allows for future production predictions, and provides the means to be systematically alert to either progress or regulatory bottlenecks that may occur relative to mine expansions or development.

1016 **Coal: keystone of energy fuels.** Schmidt, R.A. 2: No. 6, 6-11(Aug 1977).

Coal, the fuel that powered the industrialization of the American economy, is receiving renewed attention as the nation seeks domestic resources to satisfy future energy needs. If coal is to regain its position as the keystone of U.S. energy fuels, a better balance is required in dealing with several factors that control its production and consumption: issue of policy, of technology, of environmental controls, and of coal industry outlook. Coal supplies are of utmost interest to electric utilities industry.

1017 **Coal 2000: the way ahead.** Ezra, D. No. 13, 10-16(Sum 1977).

Although the Plan for coal is a systematic programme of development which takes the industry up to 1985, the NCB believes that the long lead times required for new capacity, the necessary research and development, and the likely increased dependence on coal call for a framework of planning objectives up to the end of the century--hence Coal 2000, an ongoing plan that has been submitted to the Government. In this article Sir Derek Ezra explains the need for the new plan and what it involves.

1018 **Surface Mining Control and Reclamation Act of 1977. Report of the Committee on Interior and Insular Affairs, House of Representatives together with additional, concurring, separate, and dissenting views to accompany H.R. 2 (including the Congressional Budget Office cost estimate).** Washington, DC; Committee on Interior and Insular Affairs (1977). 203p. GPO.

A House report on the 1977 Surface Mining Control and Reclamation Act includes a statement of the bill's purpose; an analysis of the needs, issues, regulation procedures, and implementation of the bill; and the committee's recommendation for adoption with suggested amendments. The bill, H.R. 2, regulates surface coal mining operations and the acquisition and reclamation of abandoned mines. The committee proposes a number of changes, but approves the concept of a cooperative regulatory program with the states and the Secretary of the Interior sharing the responsibility for implementation. Full information and public participation will be developed for coal production. The committee's recommended amendments are concerned with protecting small mine operations from excessive administrative and financial burdens, scheduling of implementation, funding for energy-impacted areas, judicial review clarifications, and the application of state programs on Federal lands. Cost estimates for fiscal years 1978 through 1982 are developed and no inflationary impact is projected. Separate and dissenting views of committee members are included. (DCK)

PETROLEUM

REFER ALSO TO CITATION(S) 167, 174

1019 **Oil industry's changing role.** Steel, D. No. 13, 17-24(Sum 1977).

Like other major oil companies, British Petroleum is diversifying into coal. Advised by the NCB, it established coal interests in Australia in the early 1970s and now has similar interests in Canada and the Transvaal. The most obvious reason for this is that by AD 2000 oil may meet no more than 20 percent of the world's primary energy demand, but, as BP's Chairman shows, international oil companies have the knowledge and experience to make valuable contributions in all aspects of fossil-fuel business, given reasonable freedom.

1020 **Oil Pollution Liability and Compensation Act. Report together with additional views (including cost estimate of the Congressional Budget Office) submitted to the House of Representatives, Ninety-Fifth Congress, First Session.** Washington, DC; Committee on Merchant Marine and Fisheries (1977). 66p. GPO.

Amendments to H.R. 6803 are proposed by the House Committee on Merchant Marine and Fisheries to accompany its unanimous recommendation for approval of a system for assigning oil spill liability and compensation. A readily assessible, unlimited fund for compensating claimants suffering oil pollution damage is felt by the committee to be an important step in providing incentives for compliance with other pollution laws without complicating the new law with specific regulations and standards for construction and operation of tankers. The report also includes a detailed analysis of the bill, budget estimates, and additional reports and views. (DCK)

NATURAL GAS

REFER ALSO TO CITATION(S) 174

1021 **Costs of cold weather and the conservation of residential heating gas.** Seidel, M.R. Washington, DC; Federal Power Commission (1977). vp. (NP—22285).

An analysis of, and supporting data for, the impact of this year's abnormally cold weather on gas consumption in the residential sector are presented. The purpose is to shed some light on three important policy issues on which there has been more speculation than data. The issues are: given the state-by-state accumulation of degree-days as of February 27, what is the amount of gas used by residences; how large a drain is this gas on the economy; and what is the impact of residential conservation. This analysis indicates that the answers to these questions are different than some of the pessimistic forecasts: residential gas use will be up about 11 percent from last year; residential gas costs will be up $3.1 billion from last year, but only $1.1 billion is a direct result of the weather; and short-run voluntary "conservation" actions, like setting thermostats back, can save large amounts (10 percent) of gas quickly on a one-shot basis; but long-run cost-effective improvements in home energy efficiency can save at least 20 percent permanently with no decrease in comfort, and form a major labor-intensive opportunity for the economy in this period of high unemployment, especially in the construction industry. This report attempts to present fully both the data and the methodology involved.

OIL SHALES AND TAR SANDS

REFER ALSO TO CITATION(S) 215

HYDROGEN AND SYNTHETIC FUELS

REFER ALSO TO CITATION(S) 17

ELECTRIC POWER

REFER ALSO TO CITATION(S) 578, 961, 972, 997

1022 (EPA—600/2-76-212, pp 87-96) **Design of electricity tariffs.** Cicchetti, C.J. (Wisconsin Office of Emergency Energy Assistance, Madison). Aug 1976.

From Symposium on environment and energy conservation; Denver, Colorado, USA (3 Nov 1975).

In Symposium on environment and energy conservation.

Time-of-day pricing as a method of pricing electricity, which could be more widely adopted in this country, is discussed. Ten basic reasons are enumerated as to why time-of-day pricing produces beneficial effects.

1023 (FEA/D—77/207) **Potential for load management in selected commercial and industrial facilities.** Jun 1977. 172p. GPO.

This study investigates the degree of flexibility commercial and industrial customers have in responding to time-differentiated rates and determines, through use of a computer model for utility planning, the cost effectiveness of major options for achieving such flexibility. A prime purpose of the study was to determine the ability of representative commercial and industrial customers to change demand patterns to benefit from time-differentiated rates. It also discusses how inadequately differentiated rate designs may not furnish adequate customer incentive to adopt an option even though it is economically viable on an overall cost/benefit basis.

1024 **Mobile gas turbines give new freedom to network planning.** Southerton, R.C. 14: No. 9, 65-66(Sep 1977).

Mobile gas turbines able to be positioned where a localized boost is needed and give flexibility to any size network have been developed by the GEC Gas Turbines Limited in England. The unit is a standard 15-megawatt power station mounted on two trailers. The company has sold over 100 units, seven of which are in service. The unit is designed to be practical for on-site power in remote sites as well as for use over several months during a construction period. Factory-assembled, it shortens the time from the point of sale to service. Shipping is handled by roll-on roll-off (RoRo) ferry. Variations in site foundations are handled by supporting the main trailer on 14 jacks and retracting the wheels. Whenever the unit is moved, the same load is returned to each jack. One multiwheel trailer carries the easily manuevered, compactly packaged power turbine, gear box, generator, and cooling system. A simple but foolproof coupling arrangement joins the two trailers. A three-minute "black start" (without external supplies) is used. (DCK)

1025 Load forecasting: modeling with judgment. Lawrence, A. 2: No. 6, 12-17(Aug 1977).

The development and implementation of new load-forecasting methods are progressing rapidly. Some new methods rely on the firm foundation of statistical time-series theory, some are built from engineering process models, and others result from micro-econometric analyses of electricity users' behavior. The new methods are more complicated and sophisticated than the pre-embargo forecasting techniques that have proved inadequate. Time-series methods are useful for short-run forecasts and will replace simple trend extrapolation techniques. Process modeling and micro-econometric modeling are promising for longer-run forecasting. These methods will supplement or displace engineering accounting techniques and aggregate econometric modeling. The implementation of advanced forecasting methods is made possible by the ever-increasing efficiency and falling costs of computerized data manipulation. Despite these advanced techniques being inseparably tied to the computer, they are certainly not automatic or cybernetic forecasting tools. The implementation of sophisticated load forecasting methods requires ever more skillful forecasters.

1026 Key to utility R and D facts. 2: No. 6, 18-19(Aug 1977).

EPRI's Research and Development Information System (RDIS) established in 1974 as a primary source of information about the R and D activities of EPRI and the U.S. electric utilities, contains details on approximately 3000 R and D projects under way or recently completed by some 90 organizations. RDIS was designed as a single authoritative source of electric utility R and D information to reduce the duplication of research effort and broaden the application of new and improved technology. Details about EPRI projects in the data base are updated monthly. Information is revised annually for the projects of other participating organizations. The data base is computerized so that access is provided through a computer terminal linked by telephone and teletype lines through the Telenet communications system to the RECON IV program of Informatics, Inc. The central computer containing the RDIS data base is located at the Informatics facility in Fairfield, New Jersey. The data base is organized in 13 major subject categories: general R and D support, hydroelectric power, nuclear power, fossil fuels, advanced power systems, transmission, distribution, stations and substations, customer utilization, economics, personnel, area development, and environmental assessment.

1027 30 R and D solutions: an application agenda. 2: No. 6, 20-27(Aug 1977).

Research results at EPRI that electric utilities can apply in their operation and planning now are summarized. In resource processing (including developments related to the processing of coal and nuclear fuels) are included high-intensity ionizer, electrostatic precipitator, bag filters for particulate control, flue gas desulfurization, NO/sub x/ control, solid waste as a boiler fuel, fuel densification, and fuel performance evaluation. Research on BWR blowdown, BWR torus, steam-water mixing, decay heat, new computer codes, tornado missile protection, crack arrest data (reactor vessels), steel fracture toughness, boiler feed pump improvement, and optimized solar energy systems is reported on dealing with energy conversion. Research covered in electrical systems are UHV transmission, HVDC transmission lines, prototype dc link, calibration of CCVTs, varistors for surge arresters, controlling decay in wood poles, splice for extruded insulation, and polymer concrete insulation. Four programs on environment, energy management, and energy R and D analysis are fossil fuel combustion and health, effects of electric fields, uranium resources and prices, and energy assessment models. (MCW)

1028 Peter Bradford: perspectives on energy. 2: No. 6, 28-33(Aug 1977).

Mr. Bradford, a Maine utility commissioner and member of EPRI's Advisory Council states his views of an energy scenario for the electric utility industry that ensures security and maximizes freedom of choice. He says, "the real key to energy security is maximizing alternatives so that if anyone source is cut off or turns out to be economically unfeasible, you won't have too many of your eggs in one basket." This means developing a mixture of technologies for coal, nuclear, hydro, and oil, plus whatever else can sensibly be used; that way, there is a mixture of plants in a mixture of locations with an appropriate mixture of transmission lines. Bradford explained in detail his belief that the government role should be to ensure freedom of choice at national, state, regional, and individual levels. He sees the electric utility industry as playing a "swing" role because of its ability to convert a variety of basic fuels into energy for a variety of uses. (MCW)

1029 Economic impact of increasing industrial electric rates above cost of service. Washington, DC; Electricity Consumers Resource Council (1977). 104p. (NP—22445). .

The increase in the cost of electricity to all consumers has set in motion proposals to moderate charges to all consumers or to shift the burden of paying from one consumer class to another. One set of these proposals would require industry to pay more than the costs of delivery so that the excess revenue would subsidize residential electricity, reducing its price below the cost of serving residential consumers. There are five important economic impacts on the U.S. of requiring industry to pay more for electricity than cost while charging residential consumers less than cost, namely: (1) effect on the costs of all goods and services purchased by the average American household; (2) impact on the overall U.S. economy as measured by gross national product, disposal income, consumption, employment, Federal government finances, and other economic indicators; (3) long-term impact on efficiency of production of goods and services and thus the standard of living in the U.S.; (4) effect on conservation of all forms of energy; and (5) differing effects on regions and industries. Since modern analytic techniques are not capable of calculating these five impacts together, this analysis focused on the first two. This report presents the methodology and results of the analysis and the conclusions drawn from it.

1030 Dynamic model of nuclear energy market share employing full-information maximum-likelihood parameter estimation via Kalman filtering. Arthur, W.B. (Univ. of Illinois, Urbana); Dorning, J.J. pp 173-177 of In Modeling and simulation. Volume 7, Part 1. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P1.

A computer simulation model was developed to study changes that have occurred in the nuclear and fossil-fuel market balance over the last twenty years. Two hypothesized model structures are parameterized and tested using a mathematical method based upon full-information maximum likelihood parameter estimation and extended Kalman filtering. Emphasis is placed on model development and validation using the statistical information generated by the filter.

1031 Pricing model for coal-based electricity. Mallik, A.K.; Curry, T.D. (West Virginia Univ., Morgantown). pp 736-738 of In Modeling and simulation. Volume 7, Part 2. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P2.

An algorithm based on engineering principles is developed to price electricity from coal-based generating stations. A thorough sensitivity analysis is conducted on the cost of unit electricity relative to fuel cost and plant operating cost. A computer program is written to predict average energy price over thirty (30) years of projected future.

1032 NUCLEUS: a simulation and modeling system applied to demographic, economic, and electricity demand forecasting problems. Goodman, F.K.; Juras, G.E. (Battelle Columbus Labs., OH). pp 963-967 of In Modeling and simulation. Volume 7, Part 2. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P2.

NUCLEUS, a dynamic simulation and modeling system, has been evolving at Battelle over the last decade and has proved a valuable research tool in numerous multidisciplinary research projects. The system began as an interpreter for dynamic simulation modeling using difference equation techniques. Today, NUCLEUS represents a large batch and on-line system with extensive data management capabilities to handle large and complex demographic, economic, land use, and electricity demand forecasting models.

1033 UTILITY1: a dynamic electricity demand and supply simulation model for evaluating load management and rate-structure policies. Fishbein, A.J.; Converse, A.O. (Dartmouth Coll., Hanover, NH). pp 1007-1012 of In Modeling and simulation. Volume 7, Part 2. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P2.

This paper describes a model, UTILITY1, to be used in forecasting electricity demand and the financial status of the utility supplying that demand. The model considers the seasonal and daily patterns of demand on the types of generating units required and the corresponding financial requirements of the utility. The basic demand, supply, and regulatory relationships are endogenous in the model. The model is of particular importance because it has the ability to evaluate the impact of load management and peak-load pricing policies on (1) the load shape the utility serves, (2) generating-capacity utilization, (3) its capacity mix planning, and (4) the utility's financial and revenue requirements. Preliminary evaluation of time-of-day pricing structures utilizing elasticity estimates from Vermont rate experiments suggests that the discounted benefits to society of electric tariff structure changes exceed additional metering costs, assuming the utility is allowed to earn adequate returns on its investment.

ELECTRIC POWER GENERATION

REFER ALSO TO CITATION(S) 971, 998

1034 (CONF-760838—, pp 19p, Paper 6) **Comparison of coal conversion processes for electric power generation.** Interess, E. (Arthur D. Little, Inc., Cambridge, MA). 1976.

From 3. annual international conference on coal gasification and liquefaction; Pittsburgh, Pennsylvania, United States of America (USA) (3 Aug 1976).

In 3rd international conference on coal gasification and liquefaction.

Although the results may vary with some utilities, the following conclusions will have widespread applicability for utilities planning their generating mix for the 1980's around coal. Advanced power systems now under development appear to have only slight potential advantage over conventional steam/electric generation with FGD. Despite the apparent risks of flue-gas desulfurization, principally system reliability, it would appear that the risks of advanced systems, which revolve mainly around coal gasification, high-temperature sulfur removal, and gas turbine life and reliability for base-load operations at high temperatures (and/or fuel cell life), are at least equivalent or more serious. Dispersed fuel cells appear to have the most promise in the intermediate-load range. Despite their relatively attractive heat rates and capital costs, dispersed fuel cells suffer in the base load range from the fact that the coal-derived fuels are expensive to produce. Gas turbines based on coal-derived distillates are attractive in the peak-load range. Solvent-refined coal for feed to a new conventional power plant is less economical than the above options. However, for an existing power plant, the SRC route may have some advantage over a flue gas desulfurization retrofit in the peak-to-intermediate range. Heavy coal liquids, more expensive to produce, are more attractive than SRC only in the peaking range where the lower power plant investment prevails. Further, liquids may be more appropriate for existing installations where conversion to burning a solid fuel may be infeasible. Methanol from coal has little attractiveness for large-scale utility use when compared with other clean fuels from coal and direct-fired coal with flue-gas desulfurization.

1035 Ambitious plan for magnetohydrodynamics aims for commercialization in 1990s. **55**: No. 6, 19-20(Jun 1977).

The most promising means of commercial conversion of coal to electricity appears to be by open-cycle magnetohydrodynamics (MHD) steam with a 50% efficiency and a competitive cost. ERDA plans a commercial-size plant for operation in 1989, following a three-stage development program. The first stage, Component Development and Integration (CDIF), will begin operating in Montana at the test site during the late 1970's to test hardware components. The Engineering Test Facility, slated for the mid 1980s, will scale up the refined components in an integrated MHD power plant and demonstrate its base load capability. The final step will be a full commercial-size plant. Competing teams from General Electric, Avco Everett Research Laboratory, and Westinghouse and Morrison-Knudsen will submit designs for the Engineering Test Facility, although Avco has been engaged in MHD research for over 20 years and pioneered in the field. Early concern that special heat-resistant materials would be needed were dispelled because coal slag forms a protective ceramic coating on the channel. Half the plant's electrical output is expected to result from a bottoming steam cycle. Air will be preheated in two stages behind the boiler rather than at the end of the MHD duct as was originally planned. (DCK)

1036 Modeling, simulation, and verification of a power plant fuel oil heating system. Davis, T.P. (Tampa Electric Co., FL); Smith, C.A. pp 356-360 of In Modeling and simulation. Volume 7, Part 1. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P1.

The dynamics of a large power plant fuel-oil heating system is modeled by mathematical analysis of a simplified model. From this model, a system of differential equations is thus obtained which is then solved using digital-computer simulation techniques. Using field data from the operating system, the simulation is corrected for errors due to the simplifying assumptions. The computer simulation may then be used as a tool to study the dynamics of the fuel-oil heating system and to develop improvements in fuel-oil heating system control.

CONSUMPTION AND UTILIZATION

REFER ALSO TO CITATION(S) 987, 993

1037 Energy on the farm. Vielvoye, R. No. 13, 33-38(Sum 1977).

Mechanization has meant a greatly increased use of fuels on the farm, to which must be added the "invisible" energy consumption of pesticide, fertilizer, and farm machinery production, etc. About 11 percent of Britain's primary energy supplies are channeled into the agriculture and food industries, and oil is the dominant fuel. Both farmers and horticulturists have been hit by energy price rises, and this article discusses their effects.

1038 Energy-management modeling for the University of Pennsylvania. Bomar, H.I.; McQuade, F.E. (Univ. of Pennsylvania, Philadelphia). pp 991-997 of In Modeling and simulation. Volume 7, Part 2. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P2.

The purpose of this paper is to present a general framework of methodologies to approach the problems of energy management and conservation at colleges, universities, and other similar institutions. Examples of the methodologies are then given as they have been utilized at the University of Pennsylvania.

UNCONVENTIONAL SOURCES AND POWER GENERATION

SOLAR

REFER ALSO TO CITATION(S) 422

1039 Near-term prospects for solar energy: an economic analysis. Ben-David, S. (Univ. of New Mexico, Albuquerque); Schulze, W.D.; Balcomb, J.D.; Katson, R.; Noll, S.; Roach, F.; Thayer, M. **17**: No. 2, 169-207(Apr 1977).

Current projections, retaining a high capital cost of $10 per square foot for installed solar collectors, find that residential solar water- and space-heating systems should be economically feasible by 1990. Earlier economic projections were poor because they were based on pre-1973 cheap energy supplies and are no longer valid. Regional scenarios are developed to show future energy prices, including price controls and curtailments, and consumer costs for both current and life-cycle use. Areas with decontrolled energy prices or natural gas shortages are shown to encourage widespread use of solar energy. Other areas may also shift because of high fuel costs or because of a combination of favorable sun and interest rates. Available capital is crucial to the expansion of solar energy use because, unlike other energy sources, there are no fuel costs. Low-income groups will suffer and present energy resource owners will enjoy windfall profits unless decontrol of prices is accompanied by taxes designed to distribute income equitably. Loan guarantees and low interest rates for investment in solar equipment could be an appropriate alternative strategy to price decontrol. (DCK)

OTHER

1040 (NP—22443) **Energy analysis of resource recovery options. Final report.** Brown, C.K.; Hopton, F.J.; Laughlin, R.G.W.; Sax, S.E. 30 Apr 1976. 153p. Dep. NTIS (US Sales Only), PC A08/MF A01.

The primary objective of this study is to assess the energy cost of several resource recovery options for municipal refuse, with some specifics of systems in Ontario. In Section 2, the procedures and methodology for energy analysis are discussed. Details on the derivation of energy analyses carried out on newspaper, glass bottles, steel cans, aluminum, and LOPAC plastic bottles are given in Sections 3 to 7. Sections 8 and 9 cover some background information on energy usage by fuel type in primary Ontario Industries and on calorific values of materials commonly found in the waste stream. Section 10 makes recommendations for future studies in the net energy analysis of resource recovery options. An extensive bibliography is provided. (MCW)

ENERGY CONVERSION

1041 (AD-A—041500) **Energy conversion. Report bibliography Jan 73—Jan 77.** Jun 1977. 313p. (DDC/BIB—77/05). NTIS PC A14/MF A01.

This bibliography contains unclassified and unlimited citations of reports giving a review of research and development pertaining to energy conversion. Four computer-generated indexes are provided: Corporate Author-Monitoring Agency, Subject, Title and Personal Author.

MHD GENERATORS

REFER ALSO TO CITATION(S) 1041

DESIGN AND DEVELOPMENT

REFER ALSO TO CITATION(S) 571, 1035

1042 (EPA—600/2-76-212, pp 230-248) **Conservation and environmental implications of open-cycle MHD.** Hals, F.A. (AVCO Everett Research Lab., Inc., MA). Aug 1976.

From Symposium on environment and energy conservation; Denver, Colorado, USA (3 Nov 1975).

In Symposium on environment and energy conservation.

It is widely recognized that the development of MHD power generation would enable a much more effective utilization of our fuel resources, in particular, our vast coal reserves with drastic reductions in pollution of air and water. It would serve the following important national goals: (1) More effective coal utilization, (2) Conservation of all types of fuels, (3) Reduced pollution of air and water, (4) Significant economic savings, and (5) Improved reliability of electric utility power systems. The important potential advantages of MHD relative to existing technology are possible because of the inherent characteristics of the MHD process. How the important goals can be reached and served by MHD and the status of MHD technology today and its future prospects are considered. The discussion centers on coal-burning, open-cycle MHD central station power generation. The conclusion reached is that the development of MHD can contribute significantly to solving the serious conservation and environmental problems associated with electrical power generation.

1043 (TID—27712) **Engineering Division liquid metal MHD study. Quarterly progress report No. 1, March 17—June 30, 1976.** 15 Jul 1976. Contract W-31-109-ENG-38. 8p. Dep. NTIS, PC A02/MF A01.

The long-range objectives of the ANL LMMHD program have been and continue to be to determine the performance of two-phase LMMHD generators under realistic operating conditions, to develop methods to predict and optimize generator performance, and to determine the performance of energy-conversion systems using this type of generator. The objectives of this project are to complete fabrication of the high-temperature sodium-argon generator test facility, to complete fabrication of the first experimental generator, and to perform the initial tests on this generator as permitted by the present funding. The four tasks included in this project are: TASK I: conduct advanced generator performance studies using low-temperature two-phase mixtures; TASK II: complete fabrication of high-temperature sodium-argon facility and first experimental generator; TASK III: evaluate the performance of present LMMHD designs at elevated temperatures; and TASK IV: evaluate advanced MHD generator designs at elevated temperatures. Progress on tasks I, II, and III is briefly outlined.

1044 (TID—27713) **Engineering Division liquid metal MHD study. Quarterly progress report No. 2, July 1—September 30, 1976.** 15 Oct 1976. Contract W-31-109-ENG-38. 10p. Dep. NTIS, PC A02/MF A01.

The long-range objectives of the ANL LMMHD program have been and continue to be to determine the performance of two-phase LMMHD generators under realistic operating conditions, to develop methods to predict and optimize generator performance, and to determine the performance of energy-conversion systems using this type of generator. The objectives of this project are to complete fabrication of the high-temperature sodium-argon generator test facility, to complete fabrication of the first experimental generator, and to perform the initial tests on this generator as permitted by the present funding. The four tasks included in this project are: TASK I: conduct advanced generator performance studies using low-temperature two-phase mixtures; TASK II: complete fabrication of high-temperature sodium-argon facility and first experimental generator; TASK III: evaluate the performance of present LMMHD designs at elevated temperatures; and TASK IV: evaluate advanced MHD generator designs at elevated temperatures. Progress on tasks I, II, and III is briefly outlined.

1045 (TID—27714) **Engineering Division liquid metal MHD study. Quarterly progress report No. 3, October 1—December 31, 1976.** 15 Jan 1977. Contract W-31-109-ENG-38. 28p. Dep. NTIS, PC A03/MF A01.

The long-range objectives of the ANL LMMHD program have been and continue to be to determine the performance of two-phase LMMHD generators under realistic operating conditions, to develop methods to predict and optimize generator performance, and to determine the performance of energy-conversion systems using this type of generator. The objectives of this project are to complete fabrication of the high-temperature sodium-argon generator test facility, to complete fabrication of the first experimental generator, and to perform the initial tests on this generator as permitted by the present funding. The four tasks included in this project are: TASK I: conduct advanced generator performance studies using low-temperature two-phase mixtures; TASK II: complete fabrication of high-temperature sodium-argon facility and first experimental generator; TASK III: evaluate the performance of present LMMHD designs at elevated temperatures; and TASK IV: evaluate advanced MHD generator designs at elevated temperatures. Progress on tasks I, II, and III is briefly outlined.

1046 (TID—27719) **Research in coal-based magnetohydrodynamics. Monthly technical progress report.** Bienstock, D. Jun 1976. 15p. Dep. NTIS, PC A02/MF A01.

System shakedown tests and the final construction details of the nominal 5 MW coal gasification-combustor pilot plant are continuing. Bids for operation and maintenance were received and evaluated. An operating and maintenance contractor was selected. Several modifications were made to the atmospheric combustion test facility to improve coal feeding and the quality of ash carryover data. Three tests were carried out at approximately 60% of stoichiometric air and coal inputs of about 250 lb/hr. An efficiency penalty of approximately 1.8 cycle points was computed for the SO_2 removal system for a 2000 MWt open-cycle MHD power plant, operating on 3 wt% sulfur Pittsburgh seam coal. Where appropriate credits can be taken, this penalty can be reduced to 1.0 cycle points. Investigation of gaseous PO_2^- ion in regard to its possible effect on coal plasma conductivity was continued. Numerous process calculations for coal combustion systems and seed regeneration were carried out. Study of the particle burnout problem, particularly as regards radiant heat transfer to the burning particle, was continued. Flow visualization experiments with the cyclone model was completed for test conditions simulating operation of the PERC pressurized cyclone gasifier. A contract authorization package for the development of a cyclone combustor computer code was completed and ERDA procurement action for this program is underway.

1047 (TID—27720) **Research in coal-based magnetohydrodynamics. Monthly technical progress report.** Bienstock, D. Jul 1976. 27p. Dep. NTIS, PC A03/MF A01.

System shakedown tests and final construction details of the 5 MW coal-gasification-combustor pilot plant are continuing. MATSCO, a subsidiary of the General Electric Company, was selected as the operating and maintenance contractor. Phase-in activities are in progress. The 304 stainless steel portions of the secondary-air line and inlet registers on the atmospheric gasifier-combustor were replaced with 310 stainless steel and 601 inconel so that secondary air preheat temperature could be raised to 2000°F. A 6.4 hour test was conducted at 59% of stoichiometric air and a coal feed rate of 227 lb/hr. The seed extraction and evaporation operations for an open-cycle MHD power plant were determined to be low energy consumption steps. By properly integrating these components into the overall plant energy balance, an efficiency penalty of only 0.06% is incurred for this system. Negotiation of the "JANAF" contract with Dow Chemical Company for preparation of thermochemical data tables for species occurring in fossil fuel

processes (liquefaction, gasification, combustion, corrosion, power generation) was completed. Software for calculation of matrix eigenvalues, as required by an ongoing effort to improve electron momentum transfer collision cross-section prediction ability for molecules of known moments (inertia and electric dipole) were implemented, and new thermodynamic data tables for CO_2^- and CO_3^- ions were prepared. Pressure loss experiments were conducted with the cyclone water model and the PERC atmospheric vertical cyclone operating both isothermally and with coal combustion. Based on rough extrapolation of data, a projected estimate of the pressure loss for the PERC pressurized cyclone gasifier is about 6% of the input total pressure.

1048 (TID—27721) Research in coal-based magnetohydrodynamics. Monthly technical progress report. Bienstock, D. Aug 1976. 21p. Dep. NTIS, PC A02/MF A01.

System shakedown tests and final construction details of the 5 MW coal-gasification-combustor pilot plant continue. MATSCO, the operations and maintenance contractor, is almost up to full strength and is actively engaged in employee training and in the preparation of operating procedures. Experiments with Rosebud seam coal under sub-stoichiometric conditions were continued in the atmospheric gasifier-combustor. Cyclone performance with a 5" ID x 6" long vortex finder installed in the cyclone exit throat proved to be unsatisfactory. The effect of a number of important process variables on the energy consumption of the MHD desulfurization scheme was examined. The permissible level of SO_2 emissions, the fraction conversion of sulfate to carbonate, and the sulfur level of the incoming coal were found to be significant. Air-to-fuel ratio in the producer gas generator and the fraction of excess reducing gas used in the regeneration did not appear to be overly critical from an energy consumption point of view. A code to automate the maximization of plasma stagnation conductivity was added to our program SCOOP (Staged Combustor Operation Optimizer Program). In addition to usual support calculations, numerous calculations were made in support of the combustor design for the Component Development and Integration Facility (CDIF). Flow visualization experiments with the cyclone flow model have indicated the side and end wall boundary layers are important with regard to the distribution of fine coal particles within the combustor.

1049 Electron concentration and mobility in a plasma of combustion products studied by means of a submillimetric interferometer with a HCN laser. Vasil'eva, I.A.; Golybkova, A.S.; Shumyatskii, B.Y.; Yundev, D.N. (High-Temperature Institute, Academy of Sciences of the USSR). **14**: No. 5, 937-942(Mar 1977).

Results are presented from an experimental study of electron concentration and mobility in a plasma of combustion products with different alkaline additives. Electron concentration and mobility are measured by means of a HCN laser and a 0.337-mm submillimetric interferometer. The temperature and concentration of the free-alkaline metal atoms are determined optically. The amount of the alkaline metal introduced into the combustion products is established by means of chemical analysis. The measurements were conducted in the temperature range (2200—2600) °K and electron concentrations above 19^{19} m^{-3}, which is the range of greatest importance for magnetohydrodynamic generators.

1050 Experimental plant with pulsed isothermal plasma generator for the study of MHD flows. Baranov, V.Y.; Bogdanets, A.D.; Lyubimov, B.Y.; Kuleshov, V.P.; Malyuta, D.D.; Mezhevov, V.S. (I. V. Kurchatov Institute of Nuclear Energy). **14**: No. 5, 942-948(Mar 1977).

A pulsed plant ($t \sim 10^{-2}$ sec) for conducting experiments on MHD plasma braking is described. A neutral-gas alkaline-doped plasma is created by an arc plasmatron, which makes possible a high degree of spatial homogeneity and stagnation temperature of 6000—7000°K. Plasma flow homogeneity is attained by a specially designed plasmatron; this homogeneity is demonstrated theoretically and experimentally. A technique for the measurement of the parameters of a plasma flow is described.

PERFORMANCE AND TESTING

1051 Liquid metals replace water steam. Kozlov, V. **4**: No. 6, 19-22(Dec 1976). (In Czech).

The techniques are described of power generation with regard to their effectiveness which depends on the efficiency of the conversion of thermal energy into electric energy. The magnetohydrodynamic conversion of energy is based on the use of induced electromotive force which results from the movement of the conductor in the magnetic field. The use of liquid metal as the working medium makes it possible to increase the initial temperature of the magnetohydrodynamic cycle to the limit of the highest technically attainable temperatures. The total efficiency of energy conversion in magnetohydrodynamic converters is 2 to 6%.

MATERIALS, COMPONENTS, AND AUXILIARIES

1052 Threshold capabilities of a pulsed MHD converter for the production of electric power with a resistive load. Asinovskii, E.I.; Ostashev, V.E. (High-Temperature Institute, Academy of Sciences of the USSR). **14**: No. 5, 956-959(Mar 1977).

Methods from optimal control theory are used to find the threshold energy characteristics of an MHD converter and its optimal operating regime with a resistive load. It is shown that optimal control of the converter is realized using a switch that disconnects an initially short-circuited external load after some time t^* has elapsed after the start of the process. It turns out that if the interval of time during which energy is released to an external resistance is decreased, this energy will increase with increasing t^*. Equations are obtained that determine the optimal relation between t^* and the external load. Different methods of connecting up the external load are discussed. It is shown that the threshold energy level produced by the plant in the case of a symmetric connection exceeds that realized if the load is connected up only at the output of the electrode system.

1053 Optimization approach to the design of the preheater for a magnetohydrodynamic powerplant. Coultas, T.; (Argonne National Lab., IL); Cornwell, L.; Minkoff, M.; Schultz, H. pp 586-589 of In Modeling and simulation. Volume 7, Part 1. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P1.

A mixed-integer nonlinear programming model of a regenerator for preheating air in the magnetohydrodynamic energy conversion process is presented. The model is an extension of a computer simulation which was used initially, and results are given illustrating significant design improvements due to the use of mathematical programming. The model of seven constraints (all highly nonlinear) in four variables (one integer) is solved using a nonlinear programming code.

DUCT ENGINEERING AND FLUID DYNAMICS

1054 Acoustic stability of subsonic flow in an MHD channel. Kolesnikov, V.K.; Khait, V.D. (High-Temperature Institute, Academy of Sciences of the USSR). **14**: No. 6, 1158-1165(May 1977).

A two-dimensional analysis is carried out for the linearized problem of acoustic stability of subsonic flow in an MHD channel. By means of the boundary conditions, allowance is made for the possibility of reflection of acoustic energy from the ends of the channel. In this case, the size of the rate of increase of the oscillations that arise plays no role since the energy of the oscillations is stored in the channel. Estimates are given which show that for arbitrary boundary conditions for the parameters for an open-cycle MHD generator, regions of instability are possible whose width increases with increasing Hall parameter.

1055 Effect of two-dimensional inhomogeneities on the properties of framed MHD channels. Medin, S.A.; Rutkevich, I.M. (High-Temperature Institute, Academy of Sciences of the USSR). **14**: No. 6, 1166-1173(May 1977).

An analytic study is carried out of the two-dimensional electrodynamic effects in ideally sectioned MHD channels of the framed type. Integral parameters of nonhomogeneity are introduced by means of which the electrical characteristics of the generators can be calculated. A discussion is given of the effect of nonhomogeneity of the mean-integral power and the electrical efficiency. The properties of framed and Faraday channels are compared. A solution is constructed for a model two-dimensional potential distribution problem which shows that for large values of the Hall parameter the power in a framed channel of rectangular cross section is substantially greater than in a Faraday channel.

1056 Increasing the electrical strength of the interelectrode gap in an MHD generator. Mazur, I.I.; Kazakevich, O.Y.; Miroshnichenko, A.A.; Terekhovskii, B.I. (Institute of Electrodynamics, Academy of Sciences of the Ukrainian SSR). **14**: No. 6, 1193-1195(May 1977).

It was demonstrated that the electrical strength of the interelectrode gap can be improved by blowing the electrodes with gas-air mixtures or with natural gas.(AIP).

THERMOELECTRIC GENERATORS

REFER ALSO TO CITATION(S) 1041

FUEL CELLS

REFER ALSO TO CITATION(S) 1041, 1100, 1101

DESIGN AND DEVELOPMENT

REFER ALSO TO CITATION(S) 571, 915

1057 (BNL—22820) **Hydrogen—halogen energy storage system for electric utility applications.** Beaufrere, A.; Yeo, R.S.; Srinivasan, S.; McElroy, J.; Hart, G. 1977. Contract EY-76-C-02-0016. 5p. (CONF-770804—7). Dep. NTIS, PC A02/MF A01.

From 12. intersociety energy conversion engineering conference; Washington, District of Columbia, United States of America (USA) (28 Aug 1977).

A techno-economic assessment is made for a hydrogen-chlorine energy storage system for electric utility load leveling and peak shaving applications. The proposed system consists of a GE Solid Polymer Electrolyte Cell, metal hydride hydrogen storage, and liquid chlorine/hydrochloric acid storage subsystems. The electrochemical cell operates under high pressure, which facilitates both hydrogen uptake by the metal hydride and production of chlorine as a liquid in the cell. The waste heat from the cell is used for decomposition of the hydride to release the stored hydrogen. Experiments carried out to date show that it should be possible to attain overall efficiencies (electric to electric) higher than 70% at high power densities (at least a factor of 5 higher than that for advanced batteries). Since the electrochemical process is reversible, the reactants for chemical and electrical generation are stored outside the cell, this system appears quite suitable for electric energy storage applications in both peaking and load leveling cycles.

1058 (TID—27748) **Fuel cell benefits: the program management office viewpoint.** Burnett, W.M. 1976. 22p. Dep. NTIS, PC A02/MF A01.

Seven studies that have provided information in the area of fuel cell benefits are briefly discussed, namely: (1) National Benefits Associated with Commercial Application of Fuel Cell Powerplants—United Technologies Corporation; (2) Fuel Cell Benefit Analysis—Argonne National Laboratory; (3) Economic Assessment of the Utilization of Fuel Cells in Electric Utility Systems—Public Service Electric and Gas Company; (4) The Role and Allowed Costs of Fuel Cells as Electric Generating Devices—Brookhaven National Laboratory; (5) ERDA Electric Utilities Study—ERDA; (6) Energy Conversion Alternatives Study—NASA, Lewis Research Center; and (7) Energy Savings Analysis—The Mitre Corporation. These studies present a wide range of possible benefits with varying conclusions as to specific benefits. However, all conclude that fuel-cell technology warrants strong Government support. The ERDA program office analyzed the results of these studies, and established a position on fuel-cell benefits. The results of that analysis are presented. The information presented includes the expected applications of fuel cells in the near term (prior to 1985) and the estimated market penetration in the year 1985. From the estimated market penetration, fuel and dollar saving predictions are derived. A summary of other potential benefits (environmental, siting, etc.) is also presented. The analysis concludes that fuel cells offer considerable potential benefits and predicts that most likely value for fuel savings in 1985 is 275,000 barrels per day and a taxpayer benefit of at least $1 billion annually.

1059 **Fuel cells.** Grehier, A.; Cheron, J. (to Institut Francais du Petrole). US Patent 4,037,023. 19 Jul 1977. Priority date 25 Feb 1975, France. 6p.

In this fuel cell formed of a stack of electrodes, each electrode is provided, on one of its faces, with protrusions or ribs of limited height which contact the opposite face of an adjacent electrode of the stack. 21 claims, 11 figures.

PERFORMANCE AND TESTING

1060 **Animal experiments with biogalvanic and biofuel cells.** Weidlich, E.; Richter, G.; von Sturm, F.; Rao, J.R.; Thoren, A.; Lagergren, H. (Siemens, Erlangen, Ger). 4: No. 3-4, 277-306(1976).

Animal experiments with biogalvanic cells have demonstrated that an average power of 80 μW can be derived continuously for at least 2 years. However, several basic problems such as tissue reaction, infection and proper encapsulation of the cell have to be clarified and ascertained before a long-range reliable power of 100 μW could be achieved "in vivo". Animal experiments with biofuel cells are still in preliminary stages. So far, the authors have derived a continuous power of 40 μW (4 μW/cm^2) at 575 mV over 150 days. This is the longest recorded period with such a high power density. The main problem in deriving higher power over longer period is to properly encapsulate the cell with materials which are hydrophilic and essentially biocompatible. 34 refs.

MATERIALS, COMPONENTS, AND AUXILIARIES

1061 (EPRI-EM—449) **Hydrogen conductors based on the beta-alumina structure. Final report.** Breiter, M.W.; Farrington, G.C.; Roth, W.L. Jun 1977. 60p. Dep. NTIS, PC A04/MF A01.

Current fuel cell technologies either operate at temperatures below 200°C where reaction rates are slow, limiting performance, or at temperatures above 500°C where material problems are severe, limiting life. Electrolytes do not exist that allow fuel cells to operate at 300 to 500°C where both performance and life might be satisfactory. A proton conductor possessing adequate conductivity and stability could provide a 300 to 500°C electrolyte for fuel cells. Compounds with the beta-alumina structure represent a promising starting point for the development of a solid electrolyte with hydronium ion or proton conductivity. This study addressed three issues critical to establishing the feasibility using beta-alumina as such a fuel cell electrolyte. The issues concerned: producibility of hydronium beta-alumina, conductivity at 300 to 500°C and at the steady-state water content, and stability at 300 to 500°C at water vapor pressures of 75 to 150 torr. It was concluded that while small crystals could be produced that were stable over the required water vapor pressure and temperature ranges, the conductivity was much too low for use as a fuel cell electrolyte.

1062 **Hydrogen-oxidizing catalyst, and fuel cell electrode using same.** Fullenwider, M.A. US Patent 4,031,291. 21 Jun 1977. Filed date 5 Apr 1976. 8p.

A hydrogen-oxidizing catalyst, comprising a body of yttrium coated with a thin surface layer of copper or platinum is described. The catalyst is preferably in powder form, and is especially useful as the catalyst at the hydrogen electrode of a fuel cell. The copper-yttrium combination shows better catalytic activity than shiny platinum in terms of current density for a given anode voltage, and the platinum-yttrium combination is even better, although more expensive than the Cu-Y combination. 15 claims, 4 figures.

1063 **Silicon carbide electrolyte retaining matrix for fuel cells.** Breault, R.D. (to United Technologies Corp.). US Patent 4,017,664. 12 Apr 1977. Filed date 2 Sep 1975. 6p.

In a fuel cell utilizing an acid electrolyte, such as H_3PO_4, the electrolyte retaining matrix is made from silicon carbide. The silicon carbide has been found to be virtually inert to H_3PO_4 at fuel cell operating temperatures and provides all the other necessary and desirable matrix properties. This matrix is expected to have a life of at least 40,000 hours under normal fuel cell operating conditions. 24 claims, 1 figure.

APPLICATIONS

REFER ALSO TO CITATION(S) 1034, 1057

ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

REFER ALSO TO CITATION(S) 968, 969, 985, 986, 987, 988, 990, 995, 1003

1064 (EPA—600/2-76-212) **Symposium on environment and energy conservation.** Ayer, F.A. (comp.). Aug 1976. 501p. (CONF-751119—). Dep. NTIS, PC A22/MF A01.

From Symposium on environment and energy conservation; Denver, Colorado, USA (3 Nov 1975).

Forty-two papers were presented at the conference. A separate abstract was prepared for 36 papers. The remaining 5 papers have been previously input to the data base. For abstracts of these see CONF-751119 in the Report Number Index. (RCK)

BUILDINGS

REFER ALSO TO CITATION(S) 500, 994, 1007

1065 (AD-A—039913) **Energy utilization index method for predicting building energy use. Volume I. Method development. Interim report.** Windingland, L.M.; Hittle, D.C. May 1977. Contract DACA23-76-C-0001. 176p. NTIS PC A09/MF A01.

This report describes development of the Energy Utilization Index (EUI) method for manually calculating monthly and annual energy consumption for buildings on military installations. The method uses basic building parameters such as U-factors, dimensions, occupancy, type of HVAC equipment, and average monthly weather conditions to arrive at a prediction for a building's monthly and annual energy use. Procedures for aggregating individual building consumption data into facility and installation consumption predic-

tions are provided. The method for correcting the predictions to account for actual weather conditions is also described. Volume I describes the development of the EUI method, tells how the method is used, and compares predictions generated by the method with actual consumption data. A comparison of + or - 4 percent was shown for one building type.

1066 (AD-A—041086) **An approach for managing an energy conservation program. Final report Dec 75—Jan 77.** Jan 1977. 58p. (NBSIR—77-1204). NTIS PC A04/MF A01.

General and specific guidelines to be followed by USAF management personnel have been developed and tabulated. These guidelines include, for example, establishing management structures to implement the detailed energy conservation programs, analyzing alternative energy conservation options for most of the Air Force Base facilities, family housing units, and special buildings. The guidelines are to be helpful for establishing and implementing short- and long-range plans for energy management, gaining support of all Base and tenant personnel, and monitoring program progress.

1067 (EPA—600/2-76-212, pp 13-16) **ERDA conservation program: the technology of improved efficiency.** Kane, J.S. (U.S. Energy Research and Development Administration, Washington, DC). Aug 1976.

From Symposium on environment and energy conservation; Denver, Colorado, USA (3 Nov 1975).

In Symposium on environment and energy conservation.

This country's industry, its buildings, and its transportation systems have been constructed at a time when energy was extremely cheap. As a result, our facilities, institutions, and lifestyle have tended to favor the use of energy over capital and labor. The uncertain availability and the not-too-distant exhaustion of low-priced energy sources require that we now examine all the ways in which our society uses energy, with the object of improving efficiencies through technological improvements. The total job to be done, however, is far more than just technical development. Conservation only occurs when and if the necessary measures are adopted by literally millions of decisionmakers. It is therefore supremely important that the entire process, from technical concepts through commercialization, be free of impediments, whether they be technical, institutional, legal, or economic. The ERDA program will examine efficiency improvements in buildings—both commercial and residential, in industry, in the transportation sector, and in our electrical energy systems. In all the work, the goal is to accelerate the introduction of energy-saving technology and practices. More efficient use of energy should be viewed as an alternative to increased energy production. If the economic considerations of production versus conservation are equal, the choice should favor conservation because of its more benign environmental and sociological impacts.

1068 (EPA—600/2-76-212, pp 51-59) **Highlights of energy conservation programs.** Hagler, H. (Hittman Associates, Inc., Columbia, MD); Bernstein, H.M. Aug 1976.

From Symposium on environment and energy conservation; Denver, Colorado, USA (3 Nov 1975).

In Symposium on environment and energy conservation.

Highlights of energy conservation opportunities in the four consuming sectors (residential, commercial, industrial, and transportation) are presented along with a brief description of the energy demand patterns through 1985 for all four sectors. In addition, a detailed discussion of some energy conservation programs conducted by Hittman Associates in the residential and commercial sectors is presented to highlight how energy is being consumed, how energy consumption can be reduced, and the impacts associated with energy conservation measures and their implementation. Programs discussed include a technology assessment of energy conservation innovations for residential structures, a study of residential energy conservation in the Baltimore/Washington area as well as in 10 other cities in the United States, and a study to analyze factors which are related to energy use in the commercial sector.

1069 (EPA—600/2-76-212, pp 80-86) **Federal initiatives to save energy in lighting and appliances.** Riegel, K.W. (Energy Research and Development Administration, Washington, DC). Aug 1976.

From Symposium on environment and energy conservation; Denver, Colorado, USA (3 Nov 1975).

In Symposium on environment and energy conservation.

Energy savings to the Nation and to individual consumers can accrue from the following approaches: research and development on new technologies that will lead to more efficient appliances, lighting systems, and control systems that govern their use; improving the energy efficiency of new appliances and lighting equipment by better incorporating presently available technology; and motivating purchasers of appliances and lighting equipment to make selections based on energy efficiency and life-cycle cost, thus creating market pressures for more efficient manufactured products. The Federal Government is engaged in programs that follow all of the above approaches. ERDA has programs for research, development, and demonstration of energy efficient technology in appliances and lighting. The FEA and the Department of Commerce conduct a Voluntary Appliance Efficiency Improvement Program, the purpose of which is to encourage implementation of presently available technology in new and more energy efficient appliances. The FEA encourages wise use of energy in lighting to conserve energy through two programs—the Federal Energy Management Program and the Lighting and Thermal Operations Program. Both Federal operations and the private sector are the targets of these efforts. Finally, consumer awareness and motivational issues relating to efficient energy utilization are being addressed in such programs as Commerce's Voluntary Appliance Labeling Program, FEA and ERDA research projects, and by legislation calling for stronger programs in all of the mentioned subject areas.

RESIDENTIAL BUILDINGS

REFER ALSO TO CITATION(S) 962, 1021

1070 (EPA—600/2-76-212, pp 390-401) **Heat pipe appliances.** Rice, J.F. (Southern California Gas Company, Los Angeles); Searight, E.F. Aug 1976.

From Symposium on environment and energy conservation; Denver, Colorado, USA (3 Nov 1975).

In Symposium on environment and energy conservation.

Recent awareness of the extent of energy shortages in this country has increased the recognition of the necessity of designing appliances which are capable of providing significant reductions in energy consumption. This should, however, be accomplished without sacrificing the ecological objective of reducing emission of toxic gases or vapors. The heat pipe appliances discussed accomplish these objectives. Heat pipes have been combined with forced combustion and jet impingement heat transfer to produce a group of gas-fired residential and commercial appliances. These appliances utilize the isothermal characteristics of heat pipes together with the inherent high efficiency and low emissions of forced combustion systems to provide improved performance compared to contemporary equipment. Included in these appliances are a commercial griddle, an oven for reconstitution of frozen foods, a deep fat fryer, and a water heater. Typical test data for these appliances show carbon monoxide levels of 10 to 100 ppM and total oxides of nitrogen concentration of 5 to 20 ppM. Cooking efficiency for the oven was improved from less than 42% for conventional equipment to 54%. For the water heater, both operating and standby losses were reduced with the combustion efficiency increased from 70% to over 80%. Similar improvements were accomplished for the other appliances. These appliances illustrate that heat pipes can be applied in useful and practical designs to provide products with significant advantages over conventional appliances, including improvements in efficiency and emissions, while providing uniformity of temperature and better temperature control.

1071 (EPA—600/2-76-212, pp 347-362) **Development and application of an optimum distillate oil burner head for residential furnaces.** Combs, L.P.; Nurick, W.H.; Okuda, A.S. (Rockwell International, Canoga Park, CA). Aug 1976.

From Symposium on environment and energy conservation; Denver, Colorado, USA (3 Nov 1975).

In Symposium on environment and energy conservation.

Experimental combustion research techniques have been used to develop an optimum, low-emission, high-efficiency head for conventional high-pressure atomizing distillate oil burners such as are used in residential space-heating furnaces and hydronic boilers. Application of the optimum oil burner head would offer both significantly reduced consumption of fuel oil and reduced emissions of air pollutants, particularly oxides of nitrogen. Current research is described which is directed toward applying the optimum head in two complementary ways. One approach is to commercialize the optimum head immediately for new and replacement OEM burners and for retrofitting existing burners at low cost. The second approach seeks additional improvement by further optimizing furnace components to match the optimum burner head, and so would provide greater benefits after a somewhat longer commercialization period.

1072 **Procedures for calculating heat losses through furnace walls (in S.I. Units).** Whittemore, O.J. Jr. (Univ., Sao Carlos, Brazil). 7: No. 2, 119-125(Jun 1976).

For the accurate design of a furnace, an engineer must calculate the heat transfer which will occur through the refractories of the furnace walls. For over 30 years, the American Society of Testing Materials (ASTM) has published procedures for calculating heat transfer. An adaptation of these procedures to the International System of Units (S.I.) is presented with several new examples of their use given.

1073 **Optimization of energy usage in electrically heated homes.** Harpster, H.E.; Eltimsahy, A.H. (Univ. of Toledo). pp 1114-1120 of In Modeling and simulation. Volume 7, Part 2. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P2.

Modeling a heat pump-driven forced-air domestic heating system and optimizing its performance using modern control theory are discussed. The system is optimized for two different modes of operation. One mode, the off-peak mode, is when a heat pump drives the heating system as well as a thermal storage system and the other mode, the peak mode, is when the thermal storage system drives the heating system. Each mode is optimized so as to minimize room temperature and control input variations.

SCHOOL, MUNICIPAL AND OTHER PUBLIC BUILDINGS

REFER ALSO TO CITATION(S) 1038

COMMERCIAL AND INDUSTRIAL BUILDINGS

REFER ALSO TO CITATION(S) 501, 1023, 1070

TRANSPORTATION

REFER ALSO TO CITATION(S) 1004, 1007, 1067, 1068

1074 (EPA—600/2-76-212, pp 69-71) **ERDA's conservation objectives in the transportation sector.** Brogan, J.J. (Energy Research and Development Administration, Washington, DC). Aug 1976.

From Symposium on environment and energy conservation; Denver, Colorado, USA (3 Nov 1975).

In Symposium on environment and energy conservation.

An overview is presented of the kinds of activities that ERDA has planned for the Transportation Sector and specific programs now being used to meet two major energy conservation objectives are explained.

1075 **Derived demand model of energy demand in the transportation sector.** Rodekohr, M.; Rubin, L. (Federal Energy Administration, Washington, DC). pp 937-942 of In Modeling and simulation. Volume 7, Part 2. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P2.

A derived demand econometric model of energy consumption in the transportation sector is presented. Each fuel, gasoline, distillate residual, jet fuel, liquefied gases and coal, is modeled separately with various procedures depending on the availability of data. It is shown that interfuel substitution possibilities are limited in the transportation sector. The importance of the capital stock in the various demand function is stressed. The capital stock and the intensity of utilization of the stock play a central role in the determination of the demand for energy in the transportation sector.

RAILWAY

1076 **Modeling and minimum-energy control of traction motor systems.** Mattis, W.E. (Pennsylvania State Univ., Media). pp 667-670 of In Modeling and simulation. Volume 7, Part 1. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P1.

A mathematical model of a traction motor system, found in ground transportation units, is presented. It is shown that the horizontal motion of the unit is related to the parameters of the traction motor through the tractive effort of the vehicle. Control schemes are then outlined and a minimum energy problem is formulated and solved.

LAND AND ROADWAY

1077 (EPA—600/2-76-212, pp 127-130) **Near-term potential for improved automobile fuel economy.** Hellman, K.H.; DeKany, J.P. (Environmental Protection Agency, Ann Arbor, MI). Aug 1976.

From Symposium on environment and energy conservation; Denver, Colorado, USA (3 Nov 1975).

In Symposium on environment and energy conservation.

There appear to be three broad vehicle-related approaches toward improving automobile fuel economy in the near term. These three approaches, which do not involve changing or modifying the type of fuel used, are (1) retrofit programs; (2) inspection, maintenance, and repair programs; and (3) improvement of new vehicle fuel economy. All three approaches appear to be compatible with environmental goals. Examples of each approach are given, and the pros and cons of each approach are discussed. Finally, some of the types of questions that must be answered before decisions as to which, if any, of the approaches should be undertaken are listed.

1078 (PB—267552) **Highway statistics. Section 3. Local highway finance and highway statistics charts, 1975. Annual report 1975.** Jun 1977. 149p. (FHWA/HP/HS—75/03).

The publication presents the 1974 highway finance data for municipalities, counties, townships, and other units of local government. The charts are a visual supplement showing relationships among highway finance, mileage, vehicles, fuels, and drivers.

1079 (PB—268627) **Computer-based resource accounting model for automobile technology impact assessment. Final report Jul 75—Feb 76.** DeWolf, J.B.; Davis, C.; Heinemann, P.C. Oct 1976. Contract DOT-TSC-1021. 74p. (R—938). NTIS PC A04/MF A01.

A computer-implemented resource accounting model has been developed for assessing resource impacts of future automobile technology options. The resources tracked are materials, energy, capital, and labor. The model has been used in support of the Interagency Task Force on Motor Vehicle Goals Beyond 1980. The report describes the methodology. Annual production requirements for up to thirty materials are accumulated. Projected demand is disaggregated among primary and secondary materials, imports and domestic sources. Capital and labor impacts of auto design changes, disaggregated by two-hundred industries are determined using a modified input/output model.

SEA AND WATER

1080 (AD-A—040032) **Lightweight propulsion systems for advanced naval ship applications. Part I. System studies. Final technical report Apr 1976—May 1977.** Kuo, S.C. May 1977. Contract N00014-76-C-0542. 286p. (UTRC/R—77-952566-5). NTIS PC A13/MF A01.

This report presents the results of system studies as part of a comprehensive study program to evaluate the technological and economic feasibility of utilizing open- and closed-cycle gas turbines integrated with fossil or nuclear heat sources for providing advanced lightweight propulsion power for future Navy capital ship applications. The level of technology considered is that judged by the Contractor to be available during the 1990's. Naval ship types which could benefit from implementing lightweight propulsion systems were selected and characterized, and performance and weight characteristics for selected propulsion machinery components were estimated. Turbomachinery technologies applicable to naval ship propulsion were reviewed, and future advances in crucial technical areas were projected. Eight reference installed power levels between 40,000 and 300,000 shp applicable to the ship types considered were selected. Basic propulsion system arrangements compatible with component capabilities were identified. From the huge number of possible combinations of propulsion system components, arrangements, and power levels for different ship types, a manageable number of practical cases were selected by use of a matrix screening process and subjected to detailed study.

PIPELINE

REFER ALSO TO CITATION(S) 174

INDUSTRY AND AGRICULTURE

REFER ALSO TO CITATION(S) 1007, 1022, 1037, 1067, 1068

1081 (EPA—600/2-76-212, pp 161-188) **Energy use, efficiency, and conservation in industry.** Essenhigh, R.H. (Pennsylvania State Univ., University Park). Aug 1976.

From Symposium on environment and energy conservation; Denver, Colorado, USA (3 Nov 1975).

In Symposium on environment and energy conservation.

Energy conservation can reduce pollutant emissions, reduce pressure on energy sources, and possibly reduce manufacturing costs. The basis for energy savings campaigns must be, first, knowing current consumption and efficiencies of use; and second, having targets of consumption and of use efficiencies for comparison. Current use is determined by energy audits. Target use is determined on the basis of several factors, including thermodynamic considerations. Furnace Analysis also provides a basis for identifying the principal factors controlling efficiency of furnaces; factors include output, excess air, processing temperature, etc. In evaluating and comparing systems and tasks, four efficiencies and three efficiency ratios are involved: the operating efficiency of the system (eta), its intrinsic efficiency (α), its maximum efficiency (eta/sub max/^{0}), and the maximum task efficiency (eta/sub max/^{0}) of the optimum system for the task; the efficiency ratio of the system (epsilon/sub s/ = eta/eta/

sub max/), the efficiency ratio for the task (epsilon/sub T/ = eta/eta/sub max/°), and the figure of the merit for the efficiency of the system at its optimum efficiency (epsilon/sub ST/ = eta/sub max//eta/sub max/°). The task efficiency ratio (epsilon/sub T/) is shown to be identical or nearly identical to the so-called "Second Law" efficiency. Evaluation of the material deployed in terms of efficiencies and the Furnace Analysis performance equations provide a basis for developing a systematic energy savings procedure. However, in spite of low overall efficiencies (25 to 35 percent in the industrial sector of the energy market, where potential for savings exists, it is nevertheless concluded that the chief barrier to more rapid progress in energy conservation is out-of-date or invalid cost accounting procedures.

1082 (NTIS/PS—77/0505) **Energy conservation: industry (a bibliography with abstracts). Report for 1964—May 1977.** Hundemann, A.S. Jun 1977. 140p. NTIS PC N01/MF N01.

Potential methods of conserving energy, including fuel and materials substitutions, are considered for various industries. Many abstracts deal with reports that also cover processes used, amount of energy consumed, and environmental considerations of energy conserving options. Industries covered include food, paper, chemical, cement, metals, petroleum refining, contract construction, synthetic rubber, plastics, drug manufacturing, and stone, clay, and glass. (This updated bibliography contains 135 abstracts. 67 of which are new entries to the previous edition.)

1083 (NTIS/PS—77/0506) **Energy conservation: policies, programs and general studies (a bibliography with abstracts). Report for 1964—Jun 1977.** Hundemann, A.S. Jun 1977. 180p. NTIS PC N01/MF N01.

Abstracts pertaining to national policies, programs, and general studies of ways to conserve energy are presented. Topic areas cover such subjects as electric load management, effects of price and taxation on energy conservation, public attitudes and behavior toward energy saving, energy savings through reduction in hot water consumption, and telecommunications substitutability for travel. (This updated bibliography contains 175 abstracts, 97 of which are new entries to the previous edition.)

ENERGY SOURCES

REFER ALSO TO CITATION(S) 1023

EQUIPMENT AND PROCESSES

REFER ALSO TO CITATION(S) 989, 1072

1084 (EPA—600/2-76-212, pp 485-504) **New processes and energy conservation in the primary metals industry.** Cherry, R.H. Jr. (Battelle Columbus Labs., OH). Aug 1976.

From Symposium on environment and energy conservation; Denver, Colorado, USA (3 Nov 1975).

In Symposium on environment and energy conservation.

Results derived from three recent studies of energy use patterns and requirements in the primary metals industries are reported. These studies were aimed at first categorizing energy and fuel use patterns in 83 metallurgical and related processing areas and, then, evaluating the theoretical potential for energy conservation. Some of the important results obtained for aluminum and copper in terms of: energy requirements; the potential for energy savings both with and without extensive process modifications; and developing or emerging process technology are discussed.

1085 (EPA—600/2-76-212, pp 505-512) **Energy conserving industrial changes and their environmental impact.** Skovronek, H.S. (Environmental Research Lab., Cincinnati). Aug 1976.

From Symposium on environment and energy conservation; Denver, Colorado, USA (3 Nov 1975).

In Symposium on environment and energy conservation.

Industry uses about 40% of the Nation's energy supplies for space heating and process needs. Economic need coupled with technological skill will lead to the development of new energy-conserving processes or practices over the coming years as one means of conserving this costly resource. An EPA study has been funded to assess the environmental impact of such innovations and to determine whether control technology is or will be available to prevent increased environmental insult from such new processes and practices. A methodology has been developed and used for the selection of the most significant industrial segments. Major processes likely to be implemented by these industries over the coming 15 years as part of the energy conservation strategy have been identified and work is underway to complete the pollution assessments.

1086 (EPA—600/2-76-212, pp 131-144) **Thermodynamic analysis of industrial energy conservation opportunities.** Hall, E.H. (Battelle Columbus Labs., OH). Aug 1976.

From Symposium on environment and energy conservation; Denver, Colorado, USA (3 Nov 1975).

In Symposium on environment and energy conservation.

Thermodynamic analyses were conducted of the processes employed in the steel, copper, aluminum, glass, synthetic rubber, selected plastics, and paper industries. Results of the calculations for these seven industries include the minimum theoretical energy, the efficiency of selected unit processes, and the effect of certain process changes on the energy use. A computer model was developed to perform the necessary calculations. The model performs the customary energy balances based on the first law of thermodynamics. More importantly, availability losses are calculated according to the second law of thermodynamics. The model is general and can be applied to an entire industrial process or to any of the unit operations which are employed within the process. The results identify where large energy or availability losses occur. The model is a powerful tool for identifying those operations in which significant fuel savings can be realized through straightforward modifications. On the other hand, the model will also show where the potential for energy conservation is limited by the irreversibilities inherent in the basic processes employed. Such a definition of the nature of the various availability losses is invaluable in directing the attention of process engineers to those operations which offer the greatest potential for overall fuel savings.

1087 (EPA—600/2-76-212, pp 153-160) **Energy conservation techniques applicable to the iron foundry's cupola.** Martin, D.J. (York Research Corp., Stamford, CT). Aug 1976.

From Symposium on environment and energy conservation; Denver, Colorado, USA (3 Nov 1975).

In Symposium on environment and energy conservation.

The cupola is the device most often used—primarily due to economic factors—for the melting of gray iron. Two events in recent years, however, have caused significant difficulties in the use of the cupola. The first event was the Clean Air Act, which promulgated an avalanche of air pollution regulations. The second event was the substantial increase in fuel prices usually associated with the OPEC embargo. Added to these is the energy wastefulness of the cupola. All three problem areas are now part of the difficulty involved in running a successful and economical cupola operation. There do exist technologies to partially alleviate all three problem areas; the results of an investigation into the feasibility of these technologies are presented.

1088 (KFK-PDV—102) **Energy distribution control in electric steel plant.** Koehle, S.; Lichterbeck, R.; Schmidt, P. Dec 1976. 53p. (In German). Dep. NTIS (US Sales Only), PC A04/MF A01.

A method is described for monitoring and controlling the energy consumption in an electric steel plant. This method has been used in a plant with four electric arc furnaces using a process computer. The energy available to the furnaces within a control interval of, e.g, 15 min, after deduction of the power requirements of non-disconnectible consumers, is allocated among the different furnaces by adjusting their voltage and by disconnection according to actual priorities. The energy distribution control allows for both lowering of energy costs and reducing production flow obstructions produced by energy limitations during maximum load periods.

1089 (NP—22389) **Energy conservation in the New Zealand Meat Export Industry. Report No. 17.** Pilling, R.G. Feb 1977. 25p. Dep. NTIS (US Sales Only), PC A02/MF A01.

For the purposes of the report the New Zealand Meat Industry has been confined to the production of meat products for export. The focal point of the report is the export meat processing works which loaded out 93 percent of New Zealand's meat exports. Production by abattoirs has been excluded. The operations of farming and transport sectors were studied in relationship to these defined works. The report is aimed at providing data on the consumption of fossil fuels and electricity by the New Zealand Meat Export Industry in order to assist in the formation of priorities for conservation and self-sufficiency measures.

1090 (PB—267040) **Applications of thermography in industry.** Hurley, C.W.; Kreider, K.G. 1977. 7p. (CONF-760886—2). Bureau of Standards, Wasington, DC.

From 3. biennial infrared information exchange meeting; St. Louis, Missouri, United States of America (USA) (24 Aug 1976).

The Bureau of Standards has been conducting a project to develop a method for assessing heat losses in industrial equipment. This project is part of the NBS industrial energy conservation program. The IR surveys have included industrial facilities such as tire, cement, copper, brick, and paper plants as well as foundries and forging plants. The infrared survey was used to detect heat losses which require maintenance and repair or improvement. Several examples are presented. In addition the IR thermographic mapping was used to analyze the total heat losses of industrial furnaces as part of the energy balance on the furnace. This quantitative heat loss study is discussed as an in-progress report.

WASTE HEAT RECOVERY AND UTILIZATION

REFER ALSO TO CITATION(S) 889, 989, 1087

1091 (EPA—600/2-76-212, pp 476-484) **Energy conservation by the renovation of high-temperature textile wastewater.** Brandon, C.A. (Clemson Univ., S.C.). Aug 1976.

From Symposium on environment and energy conservation; Denver, Colorado, USA (3 Nov 1975).

In Symposium on environment and energy conservation.

Hyperfiltration has been shown to be effective in the renovation of textile dyeing and finishing wastewaters for direct recycle at full process temperature. Direct recycle achieves conservation of resources and pollution abatement. The potential impact of the application of high-temperature hyperfiltration technology on energy conservation and environmental preservation is assessed and the cost effectiveness is determined. The potential energy conservation benefit to be realized by full utilization of direct recycle at process temperature is estimated to be about 2 x 10^6 gallons of fuel oil per day (equivalent). The high-temperature hyperfiltration research program is described with a brief discussion of preliminary results for two examples. One example of a batch-type process and one example of a continuous process is presented. These two categories of processes each represent about half the production in the textile industry.

INDUSTRIAL WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 579, 1091

MUNICIPALITIES AND COMMUNITY SYSTEMS

MUNICIPAL WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 1040

1092 (BNL—50662) **Development of a glass polymer composite sewer pipe from waste glass. Progress report No. 3, January—March 1977.** Steinberg, M.; Kukacka, L.E. May 1977. Contract EY-76-C-02-0016. 18p. Dep. NTIS, PC A02/MF A01.

Large quantities of energy and money can be conserved by recycling solid urban waste. While uses for recycled ferrous and non-ferrous metals are apparent, uses for the glass fraction have not been identified. As a result, a program to develop methods for incorporating waste glass into composites which can be used for construction materials was started in July 1976. Since that time tests to measure the properties of glass-polymer sewer pipe have been started. Field testing of full-scale specimens is also in progress. To date the results from compressive strength and three-edge bearing strength measurements indicate that the high strength properties are reproducible. The coefficient of variation is generally less than 10 percent. Hydrostatic test requirements can also be attained. Energy budgets and cost estimates are currently being made. Work accomplished during the period January 1-March 31, 1977 is described in the current report.

1093 **Recovery of energy and other resources from solid waste: an economic systems evaluation.** Stuckenbruck, L.C. (Univ. of Southern California, Los Angeles); King, C.F. 2: No. 1, 27-43(Mar 1977).

The sheer magnitude of the number of tons of solid waste produced every day in large urban areas makes it very appealing as a source of energy and other resources. However, the decision to implement an energy and resources recovery system must be based on sound economics. Every municipality is faced, or will soon be faced, with this problem. The technology and the state-of-the-art of the various processes for recovery of energy and other resources from solid waste are reviewed. The two processes which appeared to be the most viable for implementation now were chosen for detailed examination. In order to aid the decision maker, the costs of these two widely different solid waste energy and resources recovery processes have been summarized and the economic viability of each examined.

ADVANCED AUTOMOTIVE PROPULSION SYSTEMS

INTERNAL COMBUSTION ENGINES

REFER ALSO TO CITATION(S) 1077

1094 **Combustion technology for the improvement of engine efficiency and emission characteristics.** Bernhardt, W. (Volkswagenwerk AG, Wolfsburg, Ger.). pp 223-232 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

The goal of present research work in the automobile industry is to develop a low emission high fuel economy and high performance power system by the early 1990's. The implementation of this objective requires that more information on the combustion and reaction kinetics of the processes in the combustion chamber is made available. Such data can be established by experimental studies and mathematical modeling. In addition, a new combustion technology must be applied to find solutions to specific problems such as NO/sub x/ and soot formation, aldehyde emissions, and exhaust odor characteristics while maintaining good fuel economy and high engine efficiency. One of the most attractive approaches involves an intake manifold system that provides improved preparation and distribution of the fuel-air mixture by utilizing waste heat from the exhaust system. This feature provides some direct extension of the lean-burning limit of gasoline engines and considerable extension for alcohol and alcohol-gasoline fueled engines.

SPARK-IGNITION

REFER ALSO TO CITATION(S) 392

1095 (PB—266988) **Vehicle test procedure driving schedules. Final report Apr 1974—Mar 1975.** Strum, J.C. Mar 1977. 209p. (DOT-TSC-OST—75-55). NTIS PC A10/MF A01.

This report discusses the salient characteristics of driving schedules which are currently being used to determine automotive fuel economy, exhaust emissions, and component characteristics. The analyses discussed and the results reported highlight the major features of the various driving schedules and serve as a basis for future discussion and development of improved or alternative driving schedules.

1096 **Computer simulation of combustion in a stratified charge engine.** Boni, A.A.; Chapman, M.; Cook, J.L.; Schneyer, G.P. (Science Applications, Inc., La Jolla, CA). pp 1527-1541 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

A two-dimensional (axisymmetric), time-dependent simulation of the compression and power strokes of a divided-chamber stratified charge engine based on an axisymmetric approximation to the Honda CVCC configuration was performed. Global methane/air kinetics and constant turbulent diffusivities were employed. Results indicate that significant variations in the CH_4/air equivalence ratio occur near the spark plug as a result of the velocity field induced by the moving piston. These variations could cause cycle-by-cycle variations in engine performance. Vortex-like motion induced by the piston is presented along with the spatial distribution of CH_4, products, NO/sub x/, temperature and velocity at various times in the engine cycle. Unburned CH_4 is found in the prechamber at the end of the calculation.

1097 **Fundamentally based model of knock in the gasoline engine.** Kirsch, L.J.; Quinn, C.P. (Shell Research Ltd., Chester, Eng.). pp 233-244 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

A mathematical model was developed to simulate the occurrence of knock in the gasoline engine. A rapid-compression machine was used to obtain experimental information on the autoignition characteristics of a suitable range of sensitive and non-sensitive reference fuels. A generalized chemical reaction scheme which embodies the essential kinetic features of the degenerate branched chain reactions responsible for autoignition was then refined to give an accurate simulation of these observations. When incorporated in a computerized engine cycle simulation, this chemical model predicts the development of end-gas reactions and the occurrence of knock. The model was used to investigate the origin of severity in the CFR engine. In confirming that high end-gas temperatures are of major importance in de-rating sensitive fuels under "severe" engine conditions, this study lends confidence to this approach to engine simulation, and especially in the chemical aspect of the model.

DIESEL

1098 Effects of water introduction on diesel engine combustion and emissions. Greeves, G.; Khan, I.M.; Onion, G. (CAV Ltd., London). pp 321-336 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

Experimental results are presented for the effect of water injection on fuel economy and ignition delay and on exhaust emissions of smoke, CO, NO and HC for a direct injection diesel engine. Results are given for a range of water/fuel ratios and for three methods of water injection. Compared with fuel injection only, NO is reduced by up to 70% by using water injection in the air inlet or with the fuel. But while the former method increases smoke and CO, the latter method reduces CO and smoke by up to 50% together with small improvements in specific fuel consumption. However due to an increase of HC beyond a water/fuel ratio of 0.6 the NO reduction would be limited to 50% when injecting water with the fuel, though this situation could be improved by increasing the engine compression ratio. The results obtained by the authors are compared with those available in the literature. Experimental data are presented on droplet size distributions for water, fuel and all spray droplets and there is a change in the state of the water/fuel spray for water/fuel ratios greater than 0.2. Also a previously developed computer model of the diesel combustion process is used to predict the effect of water injection on NO, smoke and fuel economy. The calculations over-estimate some of the trends but show that, in addition to the thermal effect of water injection, water injection affects the rates of air entrainment and fuel/air mixing. In particular, water injected with the fuel is an additional source of injected momentum for fuel/air mixing.

1099 Prediction of nitric oxide formation in a direct injection diesel engine. Kau, C.J.; Heap, M.P.; Tyson, T.J.; Wilson, R.P. (Ultrasystems, Inc., Irvine, CA). pp 337-350 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

The development of a modular model capable of predicting heat release and nitric oxide formation in a direct injection compression ignition engine is described. The model consists of separate modules which describe cylinder thermodynamics, heat transfer, fuel spray dispersion, ignition delay, heat release and pollutant production. The model includes several empirical constants, and the sensitivity to the calculated exhaust NO concentration to the value of these constants is discussed. Model predictions have been compared with experimental data generated in a single cylinder diesel engine for several operational and engine parameters (load, injection timing, engine speed, air swirl). Based upon comparison with single cylinder test data, it is concluded that the overall predictive capability of the model with respect to pressure history and exhaust NO concentration is good. Experience gained during the development of the model indicates that calculated pollutant levels are most sensitive to fuel/air mixing parameters and nonpremixed heat release zones cannot be modeled adequately by single droplet diffusion flames.

ELECTRIC-POWERED SYSTEMS

1100 (NTIS/PS—77/0636) **Electric automobiles. Volume 1. 1970—1974 (citations from the Engineering Index data base). Report for 1970—74.** Hundemann, A.S. Aug 1977. 198p. NTIS PC N01/MF N01.

Citations from worldwide research cover the design of electric automobiles, vans, buses, and hybrid vehicles. Studies are included on lead-acid, zinc-air, lithium-sulfur, and nickel-cadmium batteries; fuel cells; drive trains; and chassis construction. (The updated bibliography contains 191 abstracts, none of which are new entries to the previous edition.)

1101 (NTIS/PS—77/0637) **Electric automobiles. Volume 2. 1975—July 1977 (citations from the Engineering Index data base). Report for 1975—Jul 77.** Hundemann, A.S. Aug 1977. 170p. NTIS PC N01/MF N01.

Citations from worldwide research cover the design of electric automobiles, vans, buses, and hybrid vehicles. Studies are included on lead-acid, zinc-air, lithium-sulfur, and nickel-cadmium batteries; fuel cells; drive trains; and chassis construction. (The updated bibliography contains 163 abstracts, 70 of which are new entries to the previous edition.) See also NTIS/PS-77/0636, Electric Automobiles. Vol. 1. 1970-1974.

EMISSION CONTROL

REFER ALSO TO CITATION(S) 1094, 1098

NITROGEN OXIDES

REFER ALSO TO CITATION(S) 1096

HYDROCARBONS

REFER ALSO TO CITATION(S) 1096

PARTICULATES

1102 In situ optical measurement of automobile exhaust gas particulate size distributions: regular fuel and methanol mixtures. Hirleman, E.D. Jr.; Wittig, S.L.K. (Purdue Univ., West Lafayette, IN). pp 245-254 of In Sixteenth symposium (international) on combustion. Pittsbu gh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

Optical techniques provide in situ, real time analysis of particulate size distributions in raw exhaust gases thereby eliminating complications inherent in conventional sampling probe-inertial impactor or other interfering methods. A new Multiple Ratio Single Particle Counter (MRSPC) was designed for the in situ analysis of combustion generated particulates in the diameter range of 0.4 μm to 3.0 μm. Detailed calibration and testing confirmed the ability of the prototype to perform the desired measurements. The instrument was initially applied to the study of particulate size distributions emitted from a four cylinder Otto engine using regular fuel and methanol mixtures. The comparison with available data taken under different experimental conditions reveals considerable discrepancies and indicates the importance of engine system parameters as well as probe characteristics. Large increases in particulate emission rates were observed during acceleration tests confirming the observation of previous studies.

ALTERNATIVE FUELS

REFER ALSO TO CITATION(S) 1094, 1102

MATERIALS

METALS AND ALLOYS

REFER ALSO TO CITATION(S) 2

1103 (AD-A—039658) **Technology of molybdenum and its alloys: proceedings of a symposium held at Rackham Memorial Building, Engineering Society of Detroit, on September 18—19, 1956.** 19 Sep 1956. 20p. (ONR-ACR—12). NTIS PC A02/MF A01.

Contents: Session I -- Molybdenum as a Structural Material - The Potential and Future of Molybdenum and Its Alloys, Properties and Applications of Commercial Molybdenum and Molybdenum Alloys; Session II -- Preparation and Fabrication of Molybdenum and its Alloys - Consolidation of Molybdenum by Powder Metallurgy Practice, Arc - Melting Molybdenum, Working of Molybdenum and Its Alloys, Joining of Molybdenum and its Alloys; European Developments on Molybdenum - Vacuum-Sintered and Vacuum-Cast Molybdenum Alloys, Molybdenum Research and Development in Great Britain; Session III -- Metallurgy of Molybdenum and Molybdenum-Base Alloys - The Ductile-to-Brittle Transition in Molybdenum, The Influence of Carbon, Oxygen, and Nitrogen on the Ductility of Molybdenum, Development and Properties of Arc-Cast Molybdenum Alloys, Powder-Metallurgy Molybdenum-Base Alloys; Session IV -- Molybdenum Alloys for Gas Turbine Applications - Design Considerations and Engine Testing of Molybdenum for Aviation Gas Turbines, The Protection of Molybdenum Against High-Temperature Oxidation, Forging of Molybdenum-Alloy Turbine Buckets, Investigation of the Effects of Hot-Cold Work on the Properties of Molybdenum Alloys.

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 1084, 1160

1104 (UCID—17500) **Fabrication of a large plutonium sphere for use in LLL pulsed-sphere experiments.** Rose, R.L. 17 Jun 1977. Contract W-7405-ENG-48. 25p. Dep. NTIS, PC A02/MF A01.

Two plutonium-alloy hemispheres were cast, machined, and canned for use in pulsed-sphere experiments. LLL physicists will use the data from these experiments to improve physics codes. The total mass of Pu—1.0 wt percent Ga was 9.3 kg. The hemispherical shapes had a radius of 53.7 mm. Both hemispheres were cast with hollow polar cones. In one casting the cone was plugged; in the other casting the cone was left to allow fitting to the neutron generator. The hemispheres were electron beam welded into close-fitting stainless steel cans so they could be used in a non-plutonium area. This report describes the fabrication of the device, which is expected to have long-term research utility. 14 figures.

1105 (UCRL—52259) **Die casting plutonium.** Rose, R.L.; Kuhn, B.A. 14 Apr 1977. Contract W-7405-ENG-48. 12p. Dep. NTIS, PC A02/MF A01.

A successful method of die casting plutonium is described. The method is an improvement over conventional pour-cast techniques in that the plutonium can be solidified more rapidly. One advantage of rapid solidification is that cast structures can be improved. Another advantage is that the plutonium has little time to react with its surroundings, so experimenters can choose from a larger selection of die construction materials.

1106 **Multifilament superconductors.** Howe, D.G. US Patent 4,002,504. 11 Jan 1977. Filed date 23 Dec 1975. 7p.

A multifilament composite superconductor comprises (1) a matrix sheath selected from the group consisting of a copper-gallium (Cu-Ga) alloy with a gallium content from 0.4 to 22 at.%, a copper-tin (Cu-Sn) alloy with a tin content from 1 to 11 at.%, and a copper-silicon (Cu-Si) alloy with a silicon content from 0.5 to 14 at.%; (2) multiple filaments embedded in said encasing matrix sheath and selected from the class consisting of a vanadium -gallium (V-Ga) alloy with a gallium content from 0.4 at.% to 12.5 at.%, a niobium-tin (Nb-Sn) alloy with a tin content from 0.1 at.% to 12.0 at.%, and vanadium-silicon (V-Si) alloy with a silicon content from 0.5 to 10 at.%; and (3) a continuous interfacial layer between said matrix and each filament of an A-15 compound selected from the class consisting of V_3Ga, Nb_3Sn, and V_3Si.

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 1777

1107 **Lattice vibrations in Rb/sub 1-c/K/sub c/ alloys: Shortcomings of a single-site coherent potential approximation.** Mostoller, M.; Kaplan, T. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). **16**: No. 6, 2350-2361(15 Sep 1977).

A single-site coherent potential approximation (CPA) including force constant changes in the additive limit (designated the CPA-F) is applied to phonons in Rb/sub 1-c/K/sub c/ alloys. The CPA-F results are in better overall agreement with the neutron scattering measurements of Kamitakahara and Copley than mass-defect CPA results. However, marked discrepancies in the concentration, branch, and wave-vector dependence and in the line shapes remain between CPA-F and experimental neutron scattering cross sections. These discrepancies suggest the need to include multiple scattering from pairs and larger clusters in the theoretical treatment.

1108 **Critical temperature of metals by the method of the electric explosion of wires under pressure.** Martynyuk, M.M.; Panteleichuk, O.G. (P. Lumumba Peoples Friendship University). **14**: No. 6, 1075-1079(May 1977).

From the enthalpy of a liquid metal at the initial point of the electric explosion of a wire under a pressure up to 6 kbar, measured by an oscillographic method, the critical temperature T/sub c/, of Cu, Ag, Au, Cd, Zn, and Al was calculated. The justification for these calculations rests on the thermodynamics and kinetics of the electric explosion of a liquid metal and its transition to a nonmetal. The critical pressure of the metals investigated was evaluated by extrapolation of the curve of the pressure of the saturated vapor to the values of T/sub c/ obtained.

1109 (ORNL-tr—4383) **Relationships between microstructure and creep fracture of a low carbon austenitic steel.** Robert, G.; Silvent, A. 1975. Translation by N. Graves from pp 741-761 of 17th colloquium of metallurgy, Saclay, France, 1974. (CONF-740688—14). 19p. MF A01.

From 17. colloquium on metallurgy, mechanical and metallurgical factors of rupture in nuclear industry; Saclay, France (24 Jun 1974).

Austenitic steel deformed by creep fracture at temperatures of 700°C has intergranular fractures. The initiation and propagation mechanism of these cracks are still not well understood. The goal of the study is to follow the development of the microstructure during creep fracture tests, and particularly during the phase called "tertiary creep" which preceeds the fracture. The tests were done using a Z CND 17/13 steel with a low carbon content and deformed by creep fracture at 700°C under an initial stress of 90 NPa. The development of the microstructure and the density of the dislocations were followed using electron microscopy during the different stages of the deformation. After a multiplication period corresponding to a primary creep stage, the dislocations arranged themselves in layers during the secondary stage. These layers delimit cells of different sizes, which quite often are smaller near the grain joints. At the end of the deformation, the number of cells decreases and the layers of dislocations are refined. A larger number of cells in the areas near the grain joints is interpreted as the result of a larger deformation in these zones. This incidence of greater deformation in intergranular fracturing will be discussed.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 660, 677, 690, 692, 733, 735, 736, 737, 771, 806, 840, 1109

1110 (AD-A—041093) **Low temperature properties of selected materials: a bibliography with descriptors.** Johnson, D.M. May 1977. Contract DSA900-76-C-2471. Mag taep. (MCIC—77-31). NTIS PC E08/MF E08.

This report is a bibliography of the work reported in the literature on the effects of low temperature on the properties of structural materials. Some of the newer areas of cryogenic technology such as superconducting machinery involve environments which may subject the components to temperature as low as 4 K. Exposure of structural materials to such low temperatures affects their properties. This bibliography contains 963 references published between 1950-1976, arranged in chronological/alphabetical order. Combined material/property indexes are provided.

1111 (AD-A—041421) **A study of constituent, dispersoid, and hardening particles in the fracture of 7075 aluminum alloys. Final report Jul 75—Feb 76.** Santner, J.S. Mar 1977. 41p. (AFML-TR—76-200). NTIS PC A03/MF A01.

Ten different alloys based on the 7075 composition are used to study the effect of purity level, dispersoid type, and heat treatment on 7075's fracture toughness. Five different purity levels ranging from 0.30 w/o to 0.30 w/o Fe+Si and two different dispersoid types were investigated. Each alloy was given two different heat treatments with both the longitudinal and the long-transverse directions tested. The notched round tensile test was modified to give the 'plastic energy per unit area'. This parameter used for ranking fracture toughness gave the same results as the total energy per unit area measured on precracked Charpy specimens. Moreover, the fracture toughness ranking for these ten alloys was the same in the longitudinal and long-transverse directions. This suggests the elongated distribution of constituent particles in the rolling direction does not change the failure mechanism. Fractographic evidence showed a clear difference in the fracture topography between the ten alloys. An analysis of variance demonstrated that heat treatment was the most significant variable investigated that affects fracture toughness. This result supports a two-stage ductile fracture failure mechanism which suggests that the dispersoid and hardening particles are primarily responsible for the fracture toughness of the higher purity aluminum alloys used by the aerospace industry today.

1112 (CONF-770545—2) **Development of A 9 Cr steel with improved strength and toughness.** Bodine, G.C. Jr.; Chakravarti, B.; Harkness, S.D.; Owens, C.M.; Roberts, B.; Vandergriff, R.; Ward, C.T. 1977. Contract W-7405-ENG-26. 5p. Dep. NTIS, PC A02/MF A01.

From British Nuclear Energy Society conference on ferritic steels for fast reactor steam generators; London, United Kingdom of Great Britain and Northern Ireland (UK) (30 May 1977).

A development program was initiated to provide an alternate code-approved advanced ferritic alloy for LMFBR use. Approximately 30 laboratory heats were made of the type 9Cr—1Mo—Nb—V—W. In elevated-temperature properties the experimental alloys are superior to code-approved and candidate commercial steels. Improvements realized in weldability, toughness, and elevated-temperature strength and stability are discussed.

1113 (CONF-770807—26) **Behavior of annealed type 316 stainless steel under monotonic and cyclic biaxial loading at room temperature.** Ellis, J.R.; Robinson, D.N.; Pugh, C.E. 1977. Contract W-7405-ENG-26. 13p. Dep. NTIS, PC A02/MF A01.

From 4. international conference on structural mechanics in reactor technology; San Francisco, California, United States of America (USA) (15 Aug 1977).

The elastic-plastic behavior of type 316 stainless steel at room temperature was studied. The stress-limited loading was restricted to two relatively simple histories, and since hardening under cyclic conditions is a concern in design, the yield behavior of type 316 stainless steel after several cycles of strain-limited loading was investigated. (GHT)

1114 (NTIS/PS—77/0504) **Cryogenic properties of aluminum and aluminum alloys (citations from the Engineering Index data base). Report for 1970—Jun 1977.** Smith, M.F. Jun 1977. 82p. NTIS PC N01/MF N01.

Reports of worldwide research on aluminum and its alloys in liquefied gas tanks, superconducting devices, pressure vessels and spacecraft components are presented. Studies on welds, fracture and mechanical properties are included. (This updated bibliography contains 75 abstracts, 11 of which are new entries to the previous edition.)

1115 (ORNL/TM—5831) **Interim analysis of the creep strain-time characteristics of annealed and isothermally annealed 2 1/4 Cr-1 Mo steel.** Booker, M.K. Jun 1977. Contract W-7405-ENG-26. 54p. .

Equations have been developed to estimate the creep-rupture and creep strain-time behavior of annealed and isothermally annealed 2¼ Cr-1 Mo steel with and without subsequent postweld heat treatment. The creep equation is based on the simple rational polynomial equation, but includes two sets of coefficients for that equation to reflect two types of behavior in this material. These two sets of coefficients allow prediction of the nonclassical creep behavior often seen in this material. Ultimate tensile strength terms in the predictive equations allow the equation to reflect variations in strength caused by heat treatment.

1116 (ORNL/TM—5906). **Heat-to-heat variation of tensile properties of annealed 2 1/4 Cr-1 Mo steel.** Klueh, R.L. Jul 1977. Contract W-7405-ENG-26. 40p. .

The tensile properties of twelve heats of 2¼ Cr-1 Mo steel were examined over the range 25 to 566°C. The twelve heats included: five air-melted tubing heats, two pieces from vacuum-arc remelted (VAR) forgings, two pieces from electroslag remelted (ESR) plates, two air-melted plates, and one air-melted forging. Tests were made on the steel in the as-received condition (vendor anneal) and, in order that all heats could be compared from a common basis, material from each of the heats was tested after it was annealed in our laboratory. For the twelve heats of steel tested, large property variations were observed. Decided differences were noted between the air-melted tubing, the air-melted plates and forging, and the ESR and VAR steels. Explanations for these differences are offered in terms of the types of precipitation reactions that occur in these steels at elevated temperatures.

1117 (UCRL—13736) **Fabrication of lead with improved strength and hardness. Final report.** Mueller, J.J. Dec 1976. Contract W-7405-ENG-48. 39p. (SANL—456-016). Dep. NTIS, PC A03/MF A01.

A program of powder fabrication of lead and calcium-alloyed lead was undertaken to assess the applicability of this approach to producing consolidated products of improved strength and hardness for use in specialized applications. The program included atomization and consolidation of low-oxide powders and evaluations of strength and hardness, shape pressing, and bonding characteristics.

1118 (UCRL—79012) **Apparatus for deformation tests at intermediate strain rates -10^{-2} to 10^{-2} s^{-1} - and at high pressure.** Abey, A.E.; Dibley, L.L. 6 Jun 1977. Contract W-7405-ENG-48. 20p. (CONF-770706—2). Dep. NTIS, PC A02/MF A01.

From 6. AIRAPT international high-pressure conference; Boulder, Colorado, United States of America (USA) (25 Jul 1977).

A new apparatus has been designed and built to test deformation at strain rates from approximately 10^{-2} to 10^{2} s^{-1}. The apparatus was designed for confining pressures up to 1 GPa, but so far interest has been in data obtained at pressures below 15 MPa. This unit is described in detail, and some one-dimensional stress data on Indiana limestone and 6061-T6 aluminum are presented.

1119 **Twin-boundary cavitation during creep in aged type 304 stainless steel.** Sikka, V.K.; Swindeman, R.W.; Brinkman, C.R. (Oak Ridge National Lab., TN). **8**: No. 7, 1117-1129(Jul 1977).

A transition from grain- to twin-boundary cavitation was observed in Type 304 stainless steel specimens aged at 593 and 649°C (1100 and 1200°F) and creep tested at 593°C (1100°F) and 207 MPa (30 ksi). Evidence of twin-boundary cavitation was also observed in unaged specimens tested at 649°C (1200°F) and 193 MPa (28 ksi). This same behavior was also found in aged Type 316 stainless steel. Several possible reasons have been suggested for the absence of frequently observed grain-boundary cavitation and its transition to twin-boundary cavitation.

1120 **Cyclic loading for materials with a vanishing elastic region.** Dafalias, Y.F.; Popov, E.P. (California Univ., Davis (USA). Dept. of Civil Engineering). **41**: No. 2, 293-302(Apr 1977).

Within a plastic internal variables formalism of rate independent plasticity, a recently developed constitutive law for plastic material response under stress reversals is shown to apply to materials with vanishing elastic region. The concept of the bounding surface introduced earlier, replaces the vanished yield and loading surfaces in defining loading-unloading criteria. Good comparison of the model with experimental data is obtained.

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 1110, 2003

1121 (AD-A—041142) **Investigation of the behavior of high-anisotropy permanent magnet materials. Final report 1 Mar 74—28 Feb 77.** Becker, J.J. May 1977. Contract N00014-74-C-0271. 33p. (SRD—77-081). NTIS PC A03/MF A01.

This report describes investigations related to the origin of the magnetic coercive force in high-anisotropy materials that have taken place over a three-year period of contract support. Such materials with sufficiently high saturation magnetization supply the basis for the development of permanent magnets superior to anything currently available. A microsample technique developed in this work has made it possible to show for the first time that conventionally sintered bulk Co_5Sm samples have magnetic properties that are defect-dominated in the same way as in particles, and show many magnetization phenomena previously seen only in single particles prepared from cast material. New measuring techniques were developed to make such observations possible. The potentially superior copper-modified alloys have been found to be dominated by domain wall pinning, in complete contrast to Co_5Sm, as shown by hysteresis loop analysis techniques that have been developed. Materials have been investigated in which both types of coercive force mechanisms coexist in the same sample and can be independently influenced. The distinction between nucleation and pinning domination is crucial to future alloy development as the desired structures are totally different.

1122 (BDX—613-1804) **Reflectance measurements of vacuum-deposited aluminum films.** Sherman, D.M. 24 Mar 1977. Contract EY-76-C-04-0613. 15p. (CONF-770339—3). Dep. NTIS, PC A02/MF A01.

From International conference in metallurgical coatings, wear erosion session; San Francisco, California, United States of America (USA) (28 Mar 1977).

An integrating sphere technique was used for the measurement of the total and specular reflectance of vacuum-evaporated aluminum films. The appearance of the surface to the naked eye was relatively insensitive to the total reflectance, but was very closely related to the fraction of reflected light that was specularly reflected. Milky or cloudy-appearing aluminum films had a low specular reflectance while mirror-like films had a high specular reflectance. Surface specular reflectance was in turn closely related to film microtopography; roughening features such as hillocks substantially reduced film shininess and hence specular reflectance. Although no extensive study to relate reflectance to deposition parameters was undertaken, specular reflectance was found to be very sensitive to chamber pressure during evaporation. Two alternate techniques for surface appearance measurements were evaluated and correlated with the integrating sphere method; these techniques yielded relative assessments of film shininess that corresponded well with visual appearance and integrating sphere results.

1123 (NTIS/PS—77/0503) **Cryogenic properties of aluminum and aluminum alloys (citations from the NTIS data base). Report for 1964—Jun 1977.** Smith, M.F. Jun 1977. 117p. NTIS PC N01/MF N01.

Citations of Federally funded research include studies on the cryogenic properties of aluminum and its alloys used in superconducting machinery, magnets, space technology and nuclear reactors. Electrical properties, fatigue, deformation and welds are included. (This updated bibliography contains 112 abstracts, 25 of which are new entries to the previous edition.)

1124 (SAND—77-0137C) **Effect of multiple refiring on the adhesion of thick film conductors.** Johnson, D.R.; Uribe, F. 1977. Contract EY-76-C-04-0789. 7p. (CONF-771019—1). MF A01.

From International microelectronics symposium; Baltimore, Maryland, USA (24 Oct 1977).

This study was designed to determine the detrimental effect of multiple refiring on the adhesion of thick film conductor materials. The conductor materials evaluated include four fritted gold-platinum-palladium compositions (Cermalloy 4100, DuPont 8653, DuPont 9596, and EMCA 180), one fritless gold-platinum composition (Cermalloy 4121), and two fritless gold compositions (DuPont 9500 and Plessy 1035). Samples for evaluation were selected after 1, 3, 5, 7, and 9 firings. Tinned copper wires were soldered and gold ribbons were parallel gap welded to the 2 mm square test pads on these samples. Adhesion was determined by a 90° peel test. Failure modes were defined and recorded as wire/ribbon failures or separation of thick film material at the conductor-ceramic interface. Evaluation of adhesion was conducted on samples in the as-welded and as-soldered condition. Additional samples were evaluated following

cyclic thermal shock (-55°C to +125°C). Measurements of resistivity and fired thickness were also conducted on the test samples.

1125 (UCRL—78782) **Thermophysical measurements on liquid metals above 4000 K.** Shaner, J.W.; Gathers, G.R.; Hodgson, W.M. 14 Apr 1977. Contract W-7405-ENG-48. 10p. (CONF-770537—8). Dep. NTIS, PC A02/MF A01.

From 7. symposium on thermophysical properties; Gaithersburg, Maryland, United States of America (USA) (10 May 1977).

Thermophysical data are presented for liquid niobium up to approximately 6000°K and for liquid lead up to approximately 5000°K. These new results are summarized along with previously obtained high temperature data for liquid molybdenum, tantalum, tungsten, and uranium.

1126 Optical properties (0.1—25 eV) of Nb-Mo and other Nb-based alloys. Black, E.S.; Lynch, D.W.; Olson, C.G. (Ames Laboratory—Energy Research and Development Administration and Department of Physics, Iowa State University, Ames, Iowa 50011). **16**: No. 6, 2337-2345(15 Sep 1977).

The dielectric functions of Nb/sub x/Mo/sub 1-x/ alloys (x = 0.2, 0.5, 0.8) and of Nb with 10-at.% Zr, with 20-at.% V, and with 20-at.% Ta were determined in the 0.1—25 eV energy range. Some of the interband region below 3 eV can be interpreted on the basis of the rigid-band model for Nb-Mo while the large structure at 4—4.5 eV cannot be so interpreted in any of the alloys using existing bands. An examination of all the alloys shows that there probably are distortions of the bands due to strain and potential differences. The transitions beginning at about 9 eV, from the Fermi level to a flat band above, are seen to have delocalized final states. All the alloys show two volume and two surface plasmons like those of Nb and Mo.

1127 5s-electron excitation energies in the rare-earth metals. Herbst, J.F.; Watson, R.E.; Baer, Y. (Brookhaven National Laboratory, Upton, New York 11973). **16**: No. 6, 2447-2452(15 Sep 1977).

We report calculations of 5s electron excitation energies for the rare-earth metals. Aside from the lack of a direct estimate of correlation effects, the method is quite similar to that we have used in calculating 4f-level positions which are in excellent correspondence with experiment. Our aim here is to assess the applicability of the technique to closed-shell core states, and we have chosen the 5s levels in view of the simplicity of their x-ray photoelectron spectra (XPS). Within the approximation of a completely screened final state, in which the atomic cell having the 5s hole is electrically neutral, the results are in good qualitative and semiquantitative agreement with XPS measurements. The disparity between theory and experiment is about 4 eV across the lanthanide series, and its sign is consistent with correlation effects. Available free-atom information only permits us to estimate the correlation energy associated with 5s excitation in ionized Cs; the estimate is of the proper sign and magnitude to bring our results into accord with experiment. We also assess the effect of the complete screening assumption by estimating excitation energies corresponding to ionized final-state cells; we find that the presence of a screening electron lowers the 5s binding energy by 4—5 eV.

1128 Electrical resistivity of La. Legvold, S.; Burgardt, P.; Beaudry, B.J.; Gschneidner, K.A. Jr. (Ames Laboratory—ERDA and Departments of Physics and Materials Science and Engineering, Iowa State University, Ames, Iowa 50011). **16**: No. 6, 2479-2481(15 Sep 1977).

The electrical resistivity of high-purity double hexagonal-close-packed (dhcp) α-La from 5 to 300 K is reported. Measurements were made on small-grained samples prepared by heat treatment of cold-worked lanthanum. Measurements were also made on samples cut in different directions from an ingot slowly cooled from the molten state. The room-temperature results were all within 2% of the mean value. Chemically pure β-La (fcc) cannot be retained at room temperature, hence, measurements were made on an fcc sample of La containing 0.2-at. % Gd and ~ 0.8-at. % total interstitial nonmetallic impurities. The cubic form has almost the same type of temperature dependence as the dhcp form, but has a 10% lower magnitude.

1129 High-field magnetoresistance of hopping transport in the disordered impurity system of the transmutation-doped Ge. Knotek, M.L. (Sandia Laboratories, Albuquerque, New Mexico 87115). **16**: No. 6, 2629-2641(15 Sep 1977).

The magnetoresistance behavior for impurity conduction of a series of transmutation-doped Ge samples (majority impurity Ga, compensation K = 0.4) with Ga impurity density N/sub A/ ranging from 3 x 10^{15} cm^{-3} to 5 x 10^{17} cm^{-3} up to fields of 110 kOe is presented. The resistivity approximates the form rho = rho_0 exp(ϵ_3/kT). At low densities (N/sub A/ 9 or $\approx$ 2 x 10^{15} cm^{-3}) the pre-exponent obeys lnrho_0(H) = lnrho_0(H = 0) + CH^2N/sub A/$^{-1}$ as Mikoshiba's theory predicts, and ϵ_3 is constant. At moderate densities, both ϵ_3 and p_0 increase with field, with the effect on rho_0 being larger than expected from the simple theory, but with a weaker functional dependence on H and N/sub A/. The ratio of transverse to longitudinal effects are consistent with percolation theory. Contrary to the results of Gadzhiev and Shlimak, we see a smooth decrease of rho_0(H) with N/sub A/ throughout the moderate-density region. At high densities, a metal-to-semiconductor transition is induced which appears to be an Anderson transition. The data are discussed in terms of the impurity polarization model of Mott and Davis, the Anderson delocalization model of Shklovskii and Shlimak, and the many-electron hopping model of Knotek and Pollak. The data indicate that while the former two models may contribute at the higher densities, the latter model more reasonably accounts for the lower-density behavior.

1130 Orthogonalized linear combinations of atomic orbitals. II. Calculation of optical properties of polymorphs of silicon. Ching, W.Y.; Lin, C.C. (Argonne National Laboratory, Argonne, Illinois 60439). **16**: No. 6, 2989-2993(15 Sep 1977).

By using the method of orthogonalized linear combinations of atomic orbitals developed recently, it is possible to obtain ab initio electronic wave functions of complex crystals like the two polymorphs of Si [Si III (BC-8) and Ge III (ST-12) structures] with basis-function sets of only moderate size. From these wave functions the dielectric functions (imaginary part) for these two Si polymorphs are obtained by computing the momentum matrix elements over the Brillouin zone. The present first-principles results are compared with previous works based on empirical methods. Possible implications on the optical-absorption properties of amorphous Si are discussed.

1131 Observation of thermally induced potential in a superconductor. Falco, C.M. (Argonne National Laboratory, Argonne, Illinois 60439). **39**: No. 10, 660-663(5 Sep 1977).

Potential differences have been measured between a normal probe and a superconducting probe attached to a superconductor held in a temperature gradient. These observations suggest that a thermoelectrically generated quasiparticle current is flowing in the superconductor and allow evaluation of the thermal transport coefficient for the quasiparticles.

1132 Electron tunneling study of the superconducting proximity effect in Pb-Cd. Toplicar, J.R.; Finnemore, D.K. (Ames Laboratory—ERDA and Department of Physics, Iowa State University, Ames, Iowa 50011). **16**: No. 5, 2072-2080(1 Sep 1977).

Electron tunneling has been used to study the superconducting state in superimposed Pb-Cd thin films in which the Pb thickness varied from 950 to 330 A. The measured transition temperature T/sub c/ varied from 7.22 to 4.86 K in the samples, and the observed energy gaps varied from 1.38 to 0.43 meV. The tunneling density of states as recorded on either side of the sandwich resembles those predicted by the McMillan model, but there are some quantitative differences. The observed phonon structure in the density of states occurs at the same energy as that in bulk Pb, and the magnitude of the structure scales with T^2/sub c/. The shape of the calculated phonon spectral function remains essentially unchanged throughout this series.

1133 Distribution of magnetic moment in Ni_3Al. Felcher, G.P.; Kouvel, J.S.; Miller, A.E. (Argonne National Laboratory, Argonne, Illinois 60439). **16**: No. 5, 2124-2130(1 Sep 1977).

The unpaired-spin density distribution in the weakly ferromagnetic ordered alloy Ni_3Al was determined by polarized-neutron diffraction measurements on a single-crystal sample of 75.9-at.% Ni. In this Cu_3Au-type structure, the local magnetization at a Ni site is similar in its radial dependence and cubic components (84% T/sub 2g/, 16% E/sub g/) to that in pure nickel, though it is much smaller in magnitude. (The magnetic moments of the excess Ni atoms in Al sites are not significantly different from those at the Ni sites.) Consistent with the tetragonal environment of each Ni site, the magnetization distribution is further lowered in symmetry, resulting in an extreme situation in which the uncompensated spin is located predominantly in the lobes directed toward Ni neighbors and hardly at all in those directed toward Al neighbors. Comparison is made with the components of the Fermi-level density of states derived from a band calculation by Fletcher; the neutron-diffraction results are found to be qualitatively in accord.

1134 Magnetic excitations in amorphous $Fe_{75}P_{15}C_{10}$. Mook, H.A.; Tsuei, C.C. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). **16**: No. 5, 2184-2190(1 Sep 1977).

Neutron-scattering techniques have been used to measure the magnetic excitations in the amorphous ferromagnet $Fe_{75}P_{15}C_{10}$. Triple-axis measurements show a distinct spin-wave excitation at small momentum transfers that closely obeys a quadratic dispersion relation E = DQ^2 for D equal to about 120 meV A^2. Time-of-flight polarized-beam measurements made in the vicinity of the first peak in S (Q) near 3 A^{-1} show excitations that reach a minimum energy at the maximum in S (Q). These excitations are similar to the roton excitations in ^{4}He except that they are rather broad in energy since they are able to decay into single-particle states. A contour map is

presented which shows the scattering measurements in the neighborhood of 3 A^{-1} and the results are compared with calculations of magnetic excitations in amorphous systems.

1135 Spin dynamics in the mixed valence alloy Ce/sub 1ts-tsx/ Th/sub x/. Shapiro, S.M.; Axe, J.D.; Birgeneau, R.J.; Lawrence, J.M.; Parks, R.D. (Brookhaven National Laboratory, Upton, New York 11973). **16**: No. 5, 2225-2234(1 Sep 1977).

Temperature-dependent neutron-scattering experiments have been performed on a polycrystalline sample of Ce/sub 0.74/Th/sub 0.26/ which undergoes a first-order γ-α valence transition at T/sub V/ ~ 150 K. By a measurement of the temperature dependence of the lattice parameter and use of Vegard's law, we estimate the temperature behavior of the valence of Ce. The Q dependence of the magnetic scattering is found to follow the form factor of the Ce^{3+} ion surprisingly well. In the inelastic scans particular attention has been paid to the subtraction of the phonon background via an inelastic study of an identically sized and shaped sample of the nonmagnetic material La/sub 0.73/Th/sub 0.27/. The corrected Ce/sub 0.74/Th/sub 0.26/ spectra have then been expressed in the form of the imaginary part of the susceptibility chi'' (Q, ω). The γ-phase dynamic susceptibility is a broad feature with significant intensity extending beyond 70.0 meV (the limit of our measurement) with a peak near ~20.0 meV. On cooling below T/sub V/ the susceptibility decreases in magnitude and broadens such that the peak is beyond 70.0 meV. These results are compared with the macroscopic magnetic susceptibility which exhibits behavior similar to chi (Q) obtained from chi'' (Q, ω) by a Kramers-Kronig analysis.

1136 de Haas—van Alphen effect and Fermi surface of Nb_3Sb. Arko, A.J.; Fisk, Z.; Mueller, F.M. (Materials Science Division, Argonne National Laboratory, Argonne, Illinois 60439). **16**: No. 4, 1387-1392(15 Aug 1977).

The results of a de Haas—van Alphen investigation of Nb_3Sb, a compound having the β-W or A-15 structure, are presented. Two families of strong frequencies are consistent with a location of surfaces at the point M in the simple cubic Brillouin zone. The larger of the two could be an open surface, but the data are inconclusive because of the occurrence of several weak frequency branches. The data are somewhat consistent with the band calculations of Mattheiss for Nb_3Sn if the Fermi level is shifted.

1137 Electronic Raman scattering from valley-orbit transitions in uniaxially stressed Ge(As). Gorman, M.; Solin, S.A. (The James Franck Institute and The Department of Physics, The University of Chicago, Chicago, Illinois 60637). **16**: No. 4, 1631-1647(15 Aug 1977).

Electronic Raman scattering from the stress-split valley-orbit transition in Ge(As) is reported for uniaxial stress along both the [111] and [110] directions. Each of the observed spectral components is shown to obey the group theoretically derived selection rules. A detailed quantitative comparison of the experimental position of the spectral components is made with the theoretical predictions of Price. Raman shifts associated with $1s\{A_1\} \rightarrow 1s$ (T/sub j/) transitions (T/sub i/ not = Az_1) can be accurately calculated using this theory. A discrepancy between theoretical predictions and the experimental results for the $1s\{A_1\} \rightarrow 1s$ (A_1) transitions is attributed to stress-induced hybridization between the 1s (A_1) and $2s\{A_1\}$ states. After including hybridization effects the agreement between theoretical predictions and the experimental spectral positions is excellent. The shear deformation potential, E/sub u/, for the 1s manifold of impurity states was determined to be 17.8 +- 0.5 eV. The experimentally determined intensities of the observed electronic Raman lines are compared with theoretical calculations for the stress-dependent Ramn cross section of the valley-orbit transition.

1138 Time-differential perturbed angular correlations using ^{161}Dy. Petitt, G.A.; Obenshain, F.E. (Georgia State University, Atlanta, Georgia 30303). **16**: No. 3, 967-970(1 Aug 1977).

The 49—25.6-keV γ-γ cascade in ^{161}Dy has been used for making time-differential perturbed-angular-correlation measurements. For ^{161}Dy in Gd_2O_3 the internal fields are so large that only the hard-core correlation is seen. For ^{161}Dy in gadolinium metal above the Curie temperature the correlation function decays exponentially due to the presence of rapidly varying time-dependent fields. The half-lives of the 25.6- and 74.6-keV levels have been measured and found to be 30.0 +- 0.5 and 3.16 +- 0.05 nsec, respectively.

1139 Neutron study of local environment effects and magnetic clustering in Fe/sub 0.7/Al/sub 0.3/. Cable, J.W.; David, L.; Parra, R. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). **16**: No. 3, 1132-1137(1 Aug 1977).

Ordered Fe/sub 0.7/Al/sub 0.3/ is ferromagnetic below 400 K but becomes paramagnetic on cooling below 170 K and then is mictomagnetic below 92 K. We have used neutron-scattering methods to probe the microscopic magnetic-moment distribution of this alloy. Diffuse scattering data show the presence of large ferromagnetic clusters throughout all of these ordered regions and that the bulk behavior results from intercluster coupling. The Bragg scattering data yield Fe moments for the different lattice sites that are consistent with, and provide refined moment values for, a previously suggested local environment model. The results are interpreted in terms of clustered regions of α-site Fe atoms with n > or = 4 and n < 4 Fe nearest neighbors.

1140 Effect of addition of transition metals on the temperature coefficient of linear expansion of titanium and vanadium. Lesnaya, M.I.; Volokitin, G.G.; Kashchuk, V.A. (N. K. Krupskaya Kherson Pedagogic Institute. Tomsk Institute of Civil Engineering). **14**: No. 6, 1072-1074(May 1977).

Results of an experimental study of the effect of small impurities of d-transition metals on the temperature coefficient of linear expansion (TCLE) of titanium and vanadium are discussed. The decrease in the TCLE of vanadium with introduction of impurities of group VI metals, and its increase when group VIII metal impurities are added, as well as the shift in the temperature of the polymorphic $\alpha \rightarrow \beta$ transition for titanium are explained in terms of the configuration models of the substance. Tungsten and tantalum are recommended as being the best doping material for vanadium. For titanium, vandaium is the best material, as it reduces the TCLE and shifts the temperature of polymorphic transition by 100—120°.

1141 Measurement of the temperature of tantalum in the solid and liquid states with rapid heating by an electric current. Lebedev, S.V.; Mozharov, G.I. (High-Temperature Institute, Academy of Sciences of the USSR). **14**: No. 6, 1132-1135(May 1977).

The method of rapid heating by a high-density electric current $j \approx 5 \times 10^{10}$ A/m^2 was used to investigate the temperature dependence of the electrical resistance R (T) of tantalum in the solid and liquid states in the temperature interval 2200—4200°K. The temperature was measured using a model of an absolutely black body. It is established that, with such heating, the dependence R (T) in the solid state does differ from the equilibrium.

1142 Topology of the isoenergetic surfaces of vanadium. Lisenko, A.A.; Ostroukhov, A.A.; Frantsevich, A.I.N. (Institute of Problems of Materials Science, Academy of Sciences of the Ukrainian SSR, Kiev). **22**: No. 3, 150-152(Mar 1977).

Approximately 50 associated plane waves were employed to calculate the Fermi surface of V. The exchange potential was taken to be in the Slater form.(AIP)

1143 Electrical resistivity and parameters of electron—phonon interaction in superconducting alloys vanadium—niobium—tantalum. Sirota, A.N.N.; Shimanskaya, N.M. (Institute of Solid State Physics and Semiconductors, Academy of Sciences of the Belorussian SSR, Minsk). **22**: No. 3, 164-165(Mar 1977).

The superconducting transition temperatures were measured for all binary and ternary alloys of the V-Nb-Ta system. The four probe method was used to determine the resistivity.(AIP)

1144 Measurement of the resistivity of alloys. Zaichenko, V.M.; Zaretskii, E.B. (Institute of High Temperature, Academy of Sciences of the USSR). **14**: No. 5, 985-987(Mar 1977).

Measurements on W-Re alloys at room temperature were made in order to study the dependence of the electric resistivity on hardening temperature.(AIP)

1145 Hartree—Slater subshell photoionization cross-sections at 1254 and 1487 eV. Scofield, J.H. (Univ. of California, Livermore). **8**: 129-137(1976).

The results of calculations of photoelectric cross-sections for the Kα lines of magnesium at 1254 eV and of aluminum at 1487 eV are presented. All of the subshell cross-sections are given for Z values up to 96. The calculations were carried out relativistically using the single-potential Hartree-Slater atomic model.

CORROSION AND EROSION

REFER ALSO TO CITATION(S) 6, 7, 8, 39, 95, 372, 660

1146 (ANL—76-106) **Physical research on liquid-metal systems. Annual report, July 1975—June 1976.** Maroni, V.A.; Calaway, W.F.; Veleckis, E.; Yonco, R.M.; Cafasso, F.A.; Burris, L. 1976. Contract W-31-109-ENG-38. 20p. Dep. NTIS, PC A03/MF A01.

Physicochemical and thermodynamic studies of liquid-lithium-containing systems have continued. Pressure-composition isotherms for the Li-H system measured by a gravimetric technique are found to be in reasonably good agreement with earlier tensimetric results. Plateau-pressure studies of the Li-H, Li-D, and Li-T systems have been made at temperatures above and below the monotectic. The observed isotope effects were found to be near the predicted values. Measurements of the solubility of LiD in liquid lithium gave results in good agreement with prior data for the solubility of LiH in lithium and confirmed that the limits on cold trapping of lithium hydrides from lithium are too high for projected fusion reactor applications. Determination of the solubility of Li_2O in liquid lithium

is nearing completion. Solubility values measured to date are slightly lower than, but in the range of, prior measurements.

1147 (COO—3459-13) **Influence of hydrogen on high cycle fatigue of polycrystalline vanadium.** Chung, D.W.; Lee, K.S.; Stoloff, N.S. Feb 1977. Contract EY-76-S-02-3459. 9p. (CONF-770613—3). Dep. NTIS, PC A02/MF A01.

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

The room temperature fatigue behavior of several polycrystalline V-H_2 alloys is described. Hydrogen extends the life of unnotched vanadium but has a deleterious effect in notched materials. Crack propagation data are correlated with tensile yield stress and cyclic strain hardening data.

1148 (DP-MS—77-46) **Role of twinning and transformation in hydrogen embrittlement of austenitic stainless steels.** Caskey, G.R. Jr. 1977. Contract EY-76-C-09-0001. 14p. (CONF-771010—1). Dep. NTIS, PC A02/MF A01.

From Conference on environmental degradation of engineering materials; Blacksburg, Virginia, USA (10 Oct 1977).

Internal hydrogen embrittlement may be viewed as an extreme form of environmental embrittlement that arises following prolonged exposure to a source of hydrogen. Smooth bar tensile specimens of three stainless steels saturated with deuterium (approximately 200 mol D_2/m^3) were pulled to failure in air at 200 to 400°K or in liquid nitrogen at 78°K. In Type 304L stainless steel and Tenelon ductility losses are a maximum around 200 to 273°K; Type 310 stainless steel is not embrittled at this hydrogen concentration. A distinct change in fracture mode accompanies hydrogen embrittlement, with fracture proceeding along coherent boundaries of preexisting annealing twins. This fracture path is observed in Tenelon at 78°K even when hydrogen is absent. There is also a change in fracture appearance in specimens with no prior exposure to hydrogen if they are pulled to failure in high-pressure hydrogen. The fracture path is not identifiable, however. Magnetic response measurements and changes in the stress-strain curves show that hydrogen suppresses formation of strain-induced α'-martensite at 198°K in both Type 304L stainless steel and Tenelon, but there is little effect in Type 304L stainless at 273°K.

1149 (ORNL/TM—5812) **Effects of helium impurities on superalloys.** Selle, J.E. Jul 1977. Contract W-7405-ENG-26. 44p. Dep. NTIS, PC A03/MF A01.

A review of the literature on the effects of helium impurities on superalloys at elevated temperatures was undertaken. The actual effects of these impurities vary depending on the alloy, composition of the gas atmosphere, and temperature. In general, exposure in helium produces significant but not catastrophic changes in the structure and properties of the alloys. The effects of these treatments on the structure, creep, fatigue, and mechanical properties of the various alloys are reviewed and discussed. Suggestions for future work are presented.

1150 Influence of impurity segregation on temper embrittlement and on slow fatigue crack growth and threshold behavior in 300-M high strength steel. Ritchie, R.O. (Massachusetts Inst. of Tech., Cambridge). **8**: No. 7, 1131-1140(Jul 1977).

Interactions between hydrogen embrittlement and temper embrittlement have been examined in a study of fracture and low growth rate (near-threshold) fatigue crack propagation in 300-M high strength steel, tested in humid air. The steel was investigated in an unembrittled condition (oil quenched after tempering at 650°C) and temper embrittled condition (step-cooled after tempering at 650°C). Step-cooling resulted in a severe loss of toughness (approximately 50 pct reduction), without loss in strength, concurrent with a change in fracture mode from microvoid coalescence to intergranular. Using Auger spectroscopy analysis, the embrittlement was attributed to the cosegregation of alloying elements (Ni and Mn) and impurity elements (P and Si) to prior austenite grain boundaries. Prior temper embrittlement gave rise to a substantial reduction in resistance to fatigue crack propagation, particularly at lower stress intensities approaching the threshold for crack growth (ΔK_0). At intermediate growth rates (10^{-5} to 10^{-3} mm/cycle), propagation rates in both unembrittled and embrittled material were largely similar, and only weakly dependent on the load ratio, consistent with the striation mechanism of growth observed. At near-threshold growth rates (less than 10^{-5} to 10^{-6} mm/cycle), embrittled material exhibited significantly higher growth rates, 30 pct reduction in threshold ΔK_0 values and intergranular facets on fatigue fracture surfaces. Near-threshold propagation rates (and ΔK_0 values) were also found to be strongly dependent on the load ratio. The results are discussed in terms of the combined influence of segregated impurity atoms (temper embrittlement) and hydrogen atoms, evolved from crack tip surface reactions with water vapor in the moist air environment (hydrogen embrittlement). The significance of crack closure concepts on this model is briefly described.

1151 Corrosion of nickel-base heat resistant alloys in simulated VHTR coolant helium at very high temperatures. Shindo, M.; Kondo, T. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). **62**: No. 12, 1540-1549(Oct 1976). (In Japanese).

A comparative evaluation was made on three commercial nickel-base heat resistant alloys exposed to helium-base atmosphere at 1000°C, which contained several impurities in simulating the helium cooled very high temperature nuclear reactor (VHTR) environment. The choice of alloys was made so that the effect of elements commonly found in commercial alloys were typically examined. The corrosion in helium at 1000°C was characterized by the sharp selection of thermodynamically unstable elements in the oxidizing process and the resultant intergranular penetration and internal oxidation. Ni-Cr-Mo-W type solution hardened alloy such as Hastelloy-X showed comparatively good resistance. The alloy containing Al and Ti such as Inconel-617 suffered adverse effect in contrast to its good resistance to air oxidation. The alloy nominally composed only of noble elements, Ni, Fe and Mo, such as Hastelloy-B showed least apparent corrosion, while suffered internal oxidation due to small amount of active impurities commonly existing in commercial heats. The results were discussed in terms of selection and improvement of alloys for uses in VHTR and the similar systems.

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 689, 768, 769, 804, 1601, 2008

1152 (BNL—22925) **Recovery of T/sub c/ by annealing of irradiated A-15 compounds.** Dew-Hughes, D.; Moehlecke, S.; Welch, D.O. 1977. Contract EY-76-C-02-0016. 27p. (CONF-770649—3). Dep. NTIS, PC A03/MF A01.

From International discussion meeting of radiation effects in superconductors; Argonne, Illinois, United States of America (USA) (13 Jun 1977).

A model has been developed for the recovery of T/sub c/ in radiation-damaged A-15 compounds. This model has been applied to isothermal annealing data at 550°C on a sample of Nb_3Ge, and to isochronal annealing (200°C to 900°C) data on V_3Si, Nb_3Ge and Nb_3Sn subjected to varying doses of fast neutrons, and on Nb_3Al of various compositions subjected to the same dose. The recovery is assumed to take place by vacancy-assisted reordering and occurs in several stages. The major low-temperature stage involves a fairly stable population of irradiation-induced vacancies. At high temperatures these are replaced by thermal vacancies. Activation energies calculated for these processes, approximately 0.6 to 1.3 eV for site interchange, and approximately 1 to 2 eV for vacancy formation, are consistent with what is known about diffusion in the A-15 structure. Activation energies show some dependence upon radiation dose, but little upon composition.

1153 (CONF-770639—1) **Effects of defect trapping and radiation-induced solute segregation on void swelling.** Okamoto, P.R.; Lam, N.Q.; Wiedersich, H. 1977. Contract W-31-109-ENG-38. 36p. Dep. NTIS, PC A03/MF A01.

From Workshop on correlation of neutron and charged particle damage; Oak Ridge, Tennessee, United States of America (USA) (8 Jun 1977).

The effects of defect trapping and radiation-induced segregation on void swelling are discussed. It is shown that the effects of trapping of interstitials and/or vacancies on swelling can be described by a modified, temperature dependent recombination rate constant in the usual coupled reaction rate equations describing swelling without trapping effects. Swelling is reduced by either vacancy or interstitial trapping; however, the interstitial-solute binding energy must exceed the difference in the motion energy of vacancies and that of interstitials to be effective. Shifts in peak swelling temperature are small; in the case of vacancy trapping this is a consequence of high steady-state and thermal vacancy-solute complex concentrations at low and at high temperatures, respectively.

1154 Correlation of neutron and nickel-ion damage in pure nickel. Packan, N.H.; Stiegler, J.O.; Farrell, K. (Oak Ridge National Lab., TN). **26**: 190-191(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

1155 D-T fusion neutron and Ni ion damage in Type 316 stainless steel. Narayan, J.; Larson, B.C. (Oak Ridge National Lab., TN). **26**: 191-192(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

1156 16-MeV H^+ and (D,T) neutron hardening correlation in nickel and niobium at 20°C. Jones, R.H.; Styris, D.L. (Battelle Pacific Northwest Lab., Richland, WA). **26**: 193-195(Jun 1977).
From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

1157 Transient ion-simulated irradiation-induced creep of nickel. Michel, D.J. (Naval Research Lab., Washington, DC); Hendrick, P.L.; Pieper, A.G. **26**: 195-196(Jun 1977).
From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

1158 Apparatus for the investigation of radiation creep in metals. DiMarzo, J.T. (Univ. of Lowell, MA); Lucas, G.E.; Surprenant, M.; Brown, G.J. **26**: 196-197(Jun 1977).
From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

1159 Structural analysis for high-temperature performance. Cramer, B.A. (McDonnell Douglas Astronautics Co.-EAST, St. Louis). **26**: 207(Jun 1977).
From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

CERAMICS, CERMETS, AND REFRACTORIES

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 262, 270, 679, 1063, 1106

1160 (NTIS/PS—77/0613) **Chemical vapor deposition. Volume 2. 1975—July 1977 (a bibliography with abstracts). Report for 1π75—Jul 77.** Smith, M.F. Jul 1977. 153p. NTIS PC N01/MF N01.
Research on chemical vapor deposition of carbon, carbides, ceramics, metals and glasses are cited. Applications of this process include optical coatings, semiconducting films, laser materials, solar cells, composite fabrication and nuclear reactor material fabrication. The physical, mechanical and chemical properties of these coatings are covered. (This updated bibliography contains 148 abstracts, 62 of which are new entries to the previous edition.)

STRUCTURE AND PHASE STUDIES

1161 Electronic structure of the thorium hydrides ThH_2 and Th_4H_{15}. Weaver, J.H.; Knapp, J.A.; Eastman, D.E.; Peterson, D.T.; Satterthwaite, C.B. (Synchrotron Radiation Center, University of Wisconsin-Madison, Stoughton, Wisconsin 53589). **39**: No. 10, 639-642(5 Sep 1977).
Photoelectron spectroscopy using synchrotron radiation has been used to study the electronic structure of single-phase stoichiometric ThH_2 and Th_4H_{15}. Th-derived conduction bands are observed together with lower-lying hybridized bonding bands. For Th_4H_{15}, a narrow d-like conduction band (~ 0.6-eV full width at half-maximum) separated from other bands by a 2-eV band gap is seen. Energy-dependent cross-section measurements for the various bands have been used to determine hybridization and angular momentum character.

1162 (ORNL-tr—4327) **Contribution to the establishment of the phase diagram for the U—O—C system by means of x-ray diffractometry at high temperatures and under controlled pressure.** Pialoux, A.; Dode, M. Translated by R.G. Mansfield from **56**: 221-228(1975). 16p. Dep. NTIS, PC A02/MF A01.
During the progressive reduction of uranium dioxide by graphite under known pressures of carbon monoxide, we have measured the lattice parameters of the compounds "UO_2" (fcc), α-"UC_2" (tetragonal) and "UC" (fcc), and have evaluated the compositions of these nonstoichiometric phases near 1770°C. By this means, and for the first time thanks to these direct measurements at such high temperatures, it has been possible to establish with precision the range of the main univariant phase fields ["UO_2", C, α-"UC_2", CO] and ["UO_2", α-"UC_2", "UC", CO]. The part of the U—C—O diagram thus mapped out completes the earlier isotherm for 1700°C determined by Henry et al. 48 refs.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 1110

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 22, 267, 1061, 1110

1163 (CONF-770537—3) **Measurement of thermal diffusivity of molten UO_2.** Kim, C.S.; Blomquist, R.A.; Haley, J.; Fischer, J.; Chasanov, M.G.; Leibowitz, L. 1977. Contract W-31-109-ENG-38. 22p. Dep. NTIS, PC A02/MF A01.
From 7. symposium on thermophysical properties; Gaithersburg, Maryland, United States of America (USA) (10 May 1977).
Thermal diffusivity was measured for molten UO_2 by the modulated electron beam technique. A thin UO_2 layer was contained in a tungsten cell which, after degassing, was welded shut to avoid material loss and vapor interference. The cell was mounted in a vacuum chamber and heated with high-energy electron beams which impinged on both faces of the cell. The power of the top electron beam was then varied sinusoidally, thereby producing a modulated temperature wave in the cell. The time required for this wave to pass through the cell, expressed as a phase shift, was then related to the thermal diffusivity of the sample.

1164 Thermal expansion of the carbides of group IV—VI metals (transition class). Fridlender, B.A.; Neshpor, V.S. (State Institute of Applied Chemsitry). **14**: No. 5, 847-850(Mar 1977).
The thermal expansion of the monocarbides (MeC) and lower carbides (Me_2C) of the Group IV—VI transition metals was studied between room temperature and 2000 and 500°C, respectively. The thermal-expansion coefficient (TEC) of the Me_2C falls on passing from the lower carbides of the Group IV metals to the carbides of the Group VI metals; this is associated with an increment in the strength of the bonds between the metal atoms in the carbides. On considering the monocarbides of the transition metals a "double periodicity" appears in the relationship between the TEC and the order (atomic) number of the metal component. This is associated with the repulsive contribution to the bond energy from the screened Me—Me bonds.

1165 (LA—6757) **Melting point of yttria.** Skaggs, S.R. Jun 1977. Contract W-7405-ENG-36. 8p. Dep. NTIS, PC A02/MF A01.
Fourteen samples of 99.999 percent Y_2O_3 were melted near the focus of a 250-W CO_2 laser. The average value of the observed melting point along the solid-liquid interface was 2462 +- 19°C. Several of these same samples were then melted in ultrahigh-purity oxygen, nitrogen, helium, or argon and in water vapor. No change in the observed temperature was detected, with the exception of a 20°C increase in temperature from air to helium gas. Post test examination of the sample characteristics, clarity, sphericity, and density is presented, along with composition. It is suggested that yttria is superior to alumina as a secondary melting-point standard.

1166 NMR studies of the helium distribution in uranium tritide. Bowman, R.C. Jr.; Attalla, A. (Mound Laboratory, Monsanto Research Corporation, Miamisburg, Ohio 45342). **16**: No. 5, 1828-1843(1 Sep 1977).
The distribution of helium (^3He) created in uranium tritide (UT_3) by triton decay has been investigated by pulse NMR techniques. The line shapes and relaxation times for ^3He nuclei have been measured during a 3-year period. NMR samples were prepared from five UT_3 synthesis batches. Because UT_3 is a highly paramagnetic material which ferromagnetically orders below approximately 180 K, inhomogeneous magnetic field effects contributed to the NMR parameters. Detailed analyses of the frequency, temperature, and age dependences of these NMR parameters indicate most ^3He atoms are retained in microscopic gas bubbles with dimensions < 500 A. No evidence was obtained to suggest significant concentrations of interstitial ^3He atoms in the UT_3 lattice. A simple model based upon the nucleation, growth, and subsequent rupture at critical dimensions of helium bubbles is presented. This model qualitatively describes the ^3He relaxation times and the observed ^3He retention in UT_3 powders.

1167 Interstitial compounds. Bennett, L.H.; McAlister, A.J.; Watson, R.E. (Institute for Materials Research, National Bureau of Standards, Washington D. C.). **30**: No. 9, 34-41(Sep 1977).
Applications of these materials derive from their hardness, high melting points and, in some cases, catalytic and magnetic properties and superconductivity; yet their electronic structure is still something of a mystery.

1168 Low-frequency inelastic light scattering from chalcogenide glasses and alloys. Nemanich, R.J. (Department of Physics, James Franck Institute, University of Chicago, Chicago, Illinois 60637). **16**: No. 4, 1655-1674(15 Aug 1977).
Polarized low-frequency Raman and Brillouin spectra of the chalcogenide glasses As_2S_3, GeS_2, $GeSe_2$, and As_2Se_3 and the glass alloy system (As_2S_3)/sub 1-x/(GeS_2)/sub x/ have been measured using the near infrared 7525 or 7993 A lines of a krypton laser. The low-temperature T ~ 10 K spectra of the four binary glasses indicate that the Raman coupling constant exhibits an ω^2 frequency dependence in the limit $\omega \rightarrow 0$. In addition it is demonstrated that the spectral distribution of the low-frequency low-temperature Raman coupling constant can be described by a model proposed by Martin and Brenig. By fitting the predicted spectra of the model to the

experimentally obtained spectra, the structural correlation ranges of the glasses have been determined. It is found that the structural correlation ranges of the As_2S_3 and As_2Se_3 glasses are 6.5 +- 1 A, while those of the GeS_2 and $GeSe_2$ glasses are 8.5 +- 1 A. These results are compared with values of structural correlations obtained from x-ray diffraction spectra and optic-mode Raman spectra. The depolarization spectra predicted from the Martin and Brenig model are found to deviate significantly from the observed low-frequency depolarization spectra of the chalcogenide glasses. At higher temperatures the low-frequency Raman spectra of all samples exhibit a feature apparently centered at 0 frequency shift which cannot be described by the model of Martin and Brenig. A similar feature termed the light scattering excess has been reported for the low-frequency Raman spectrum of fused silica. The composition dependence of both the structural correlation range and the light-scattering excess is presented for the alloy system of (As2S3)/sub 1-x/(GeS2)/sub x/.

1169 ESR observation of a noncubic phase in pure yttrium oxide. Vainer, V.S.; Veinger, A.I. (A. F. Ioffe Physicotechnical Institute, USSR Academy of Sciences, Leningrad). **19**: No. 5, 813-815(May 1977).

An investigation of the complicated angular dependence of the ESR spectra of an impurity Fe^{3+} ion in pure yttrium oxide has revealed the presence of noncubic inclusion in the oxide. This application of ESR uncovers hitherto unemployed methodological capabilities of the method. An analysis of the spin Hamiltonian of the spectrum, with parameters D=1100 Oe, E/D=0.15, and B_4^0, B^2_4,B^4_4≅2—3 Oe has made it possible to identify two groups of lines of the spectrum, with g- factors g/sub z/1=4.806, g/sub x/1=3.988, g/sub y/1=3.677 in the first and g/sub z/2=3.6, g/sub x/2=3.4, and g/sub y/2=5.0 in the other, corresponding to the two transitions <-3/2vertical-bar*bold-arrow-left-rightvertical-bar-5/2> and <+1/2vertical-barbold-arrow-left-rightX+3/2>, respectively. Examination under a microscope has confirmed the presence of oriented inclusions of noncubic phase, with dimensions 5—15 μ. Judging from its chemical compositions, the inclusions constitute and heretofore unknown yttrium silicate, 86% Y_2O_3+14% SiO_2.

CORROSION AND EROSION

REFER ALSO TO CITATION(S) 20

COMPOSITE MATERIALS

PHYSICAL PROPERTIES

1170 Effective thermal diffusivity for a multimaterial composite laminate. Schimmel, W.P. Jr.; Beck, J.V.; Donaldson, A.B. (Sandia Laboratories, Albuquerque, New Mexico). **99**: No. 3, 466-470(Aug 1977).

This paper discusses the development of an "effective thermal diffusivity" which can be used to estimate the temperature response at the insulated rear surface of a multilayer composite to a step in temperature at the front surface of the composite. An example is considered using the effective value along with the mathematics of a single layer problem, and results thereof are compared with both those of an exact solution, and those which use an effective diffusivity computed from a "lumped" parameter model.

RADIATION EFFECTS

1171 (AD-A—041283) Response of graphite composites to laser radiation. Final scientific report 1 Feb 1976—30 Apr 1977. Kibler, K.G.; Carter, H.G.; Eisenmann, J.R. Mar 1977. Contract F44620-76-C-0030. 116p. (FZM—6661). NTIS PC A06/MF A01.

Experimental and analytical investigations of the response of graphite-epoxy composite tensile coupons to laser radiation have been performed. Three different 5208/T300 laminates were used to compare stacking sequence effects, three thicknesses of one of the laminates were studied, and an aluminum alloy was employed for comparison purposes. The experimental program has concentrated on laser-induced controlled-depth damage, physical characterization of the damaged area, and residual tensile strength measurements. Thermal response measurements were conducted on selected specimens to aid in assessing the damage mechanisms and to formulate a penetration model. An additional feature of the experiments included laser exposure of preloaded specimens to determine the requisite energy-to-fracture. By considering the material response in three different incident intensity ranges, there were delineated the interactions which occur and formulated models which predict the thermal response, mass ablation, and penetration in those ranges. The strength retention for partially penetrated, laser-damaged composites is describable in terms of fracture-mechanics-based predictions at all but the lowest intensity investigated, where essentially only resin sublimation occurs. Painted aluminum is more susceptible than composites to damage at high intensity, while strength retentions are similar at intermediate intensities.

POLYMERS AND PLASTICS

MECHANICAL PROPERTIES

1172 (UCRL—13732) Effect of temperature and cross-linkings on the flow behavior of a rubberized epoxy resin. Final technical report. Mukherjee, A.K.; Ling, S. 2 May 1977. Contract W-7405-ENG-48. vp. Dep. NTIS, PC A04/MF A01.

The effect of cross-linking and temperature on the flow behavior of rubber modified phenolic epoxy resin cured with amine mixture was investigateed between the temperature range of 296°K to 406°K by means of creep test and tensile test. This epoxy matrix system may be deformed by reorientation of chain segments between cross-links. Deformation in these segments may be restrained by dispersed rubber spheres. Both the creep curves and the activation energy for flow suggest that the degree of cross-linking may have increased during testing. This increase is both temperature and stress aided. Over the conditions studied the flow of such a system can be approximated by: epsilon/sub T/ = A(sigma/sub U//sigma/sub TR/)/sup n/ exp(-Q/sub T//RT), where epsilon/sub T/ is true strain rate, A is the structural factor (a constant), sigma/sub U/ is ultimate stress, sigma/sub TR/ is "stress at transition", n is mechanism dependent stress exponent, Q/sub T/ is true activation energy, R is a gas constant, and T is the absolute temperature.

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 590

OTHER MATERIALS

PREPARATION AND MANUFACTURE

REFER ALSO TO CITATION(S) 426, 444, 1160

1173 (SAND—77-1159C) Elastomeric syntactic foams for stress relief of electronic components. Rand, P.B. 1977. Contract EY-76-C-04-0789. 16p. (CONF-771020—1). Dep. NTIS, PC A02/MF A01.

From 23. technical conference of the cellular plastics division; San Francisco, California, USA (26 Oct 1977).

Elastomeric syntactic foams have been developed for use as stress relief coatings on electronic components in encapsulated electronic assemblies. Polysulfide, silicone, and polyurethane elastomers blended with microbubbles made from glass and phenolic resins have all been used to formulate syntactic foams for various applications. These foams are used to minimize the stresses caused by differential thermal expansion between the component and the encapsulant in electronic assemblies. Compressive stress strain curves have been used to determine the effects of temperature, formulation, and test configuration on these foams. The microbubble-resin blends are fluid enough to evacuate and pour before curing. These foams may be applied using a low-pressure injection molding technique or by simply brushing or dipping. Testing techniques, necessary to evaluate these sheets of elastomeric syntactic foams, were developed. These elastomeric syntactic foams have proven to be easily formulated, versatile materials that have been used in many applications to relieve the stresses caused by differential thermal expansion.

STRUCTURE AND PHASE STUDIES

1174 (UCRL—79036(Rev.1)) Three-phase region of D_2-DT-T_2. Souers, P.C.; Kelly, E.M.; Roberts, P.E.; Fearon, D.; Tsugawa, R.T. 23 Jun 1977. Contract W-7405-ENG-48. 21p. (CONF-770801—6). Dep. NTIS, PC A02/MF A01.

From Cryogenic engineering conference; Boulder, Colorado, United States of America (USA) (2 Aug 1977).

Analogous to the triple point of a pure substance are a binary mixture's triple line and a ternary mixture's three-phase surface, where pressure, temperature, and composition must all be considered. The first three-phase study on a ternary hydrogen system, D_2-DT-T_2, is reported.

1175 Parametric energy level analysis of Ho^{3+}: $LaCl_3$. Crosswhite, H.M.; Crosswhite, H.; Edelstein, N.; Rajnak, K. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). **67**: No. 7, 3002-3010(1 Oct 1977).

A 20-parameter least-squares fit to the levels of Ho^{3+}:$LaCl_3$ observed by Dieke and Pandey has been obtained. The results are in substantial agreement with their assignments and with the subsequent analysis of Rajnak and Krupke. A considerably more extensive atomic Hamiltonian was used, including operators for two- and

three-particle electrostatic interactions, spin—orbit and spin—other-orbit magnetic interaction, two-particle pseudomagnetic configuration-mixing interactions, and single-particle crystal-field interactions. The fit of twenty parameters to 128 observed levels resulted in a mean error of 5.2 cm^{-1}. The results are consistent with similar recent studies of Nd^{3+} and Pm^{3+} in the $LaCl_3$ host.

1176 Lattice dynamics of fcc helium at high pressure. Eckert, J.; Thomlinson, W.; Shirane, G. (Brookhaven National Laboratory, Upton, New York 11973). **16**: No. 3, 1057-1067(1 Aug 1977).

The neutron-inelastic-scattering technique was used to measure the phonon dispersion relations in a high-density crystal of fcc He at 38 K. The crystal was grown at a pressure of 4.93 kbar and a temperature of 38.5 K in a high-pressure sample holder. Its lattice parameter was determined to be 3.915 +- 0.002 A, equivalent to a molar volume of 9.03 cm^3/mol. The measured dispersion curves were found to be in good agreement with a recent calculation by Goldman using the first-order self-consistent phonon theory without short-range correlation functions. The strong anharmonic effects observed in earlier measurements on the crystals of 21 cm^3/mol were found to be much less prominent in this He crystal. The magnitude of the multiphonon interference effects on the one-phonon intensities is shown to be less than half of that observed in the low-density crystals. Thermodynamic analysis of the data yielded Θ/sup M//sub D/ = 154 K which indicates that the ratio of mean amplitude of vibration to the nearest-neighbor distance is 8.6%, as opposed to nearly 30% for the lowest-density He crystals. The dependence of the phonon energies on volume is discussed with reference to the earlier work of Traylor et al. on an fcc crystal at 11.7 cm^3/mol. Limited measurements were also made at 22 K to determine the temperature dependence of the phonon energies. Unusually large isochoric temperature shifts of as much as 15% for some phonons close to the zone center were found over the range of 22—38 K.

1177 Raman spectroscopic study of hexavalent chromium in some silicate and borate glasses. Brawer, S.A.; White, W.B. (Pennsylvania State Univ., University Park). **12**: No. 3, 281-288(Mar 1977).

The polarized Raman spectra of chromium-doped silicate and borate glasses have been measured and interpreted. It is shown that hexavalent chromium exists in silicate glasses as isolated chromate anions (CrO_4^{2-}). In binary sodium borate glasses there is a change of species from chromate to dichromate as the B_2O_3 concentration is increased.

PROPERTIES

REFER ALSO TO CITATION(S) 590, 1118, 1770

1178 High pressure studies of interimpurity (donor—acceptor) luminescence in ZnS and ZnSe phosphors. House, G.L.; Drickamer, H.G. (School of Chemical Sciences and Materials Research Laboratory, University of Illinois, Urbana, Illinois 61801). **67**: No. 7, 3221-3226(1 Oct 1977).

The effect of pressure has been measured on the emission peak location, half-width, integrated intensity, and lifetime for a series of ZnS phosphors doped with Cu^+ or Ag^+ with Cl^-, Al^{+3}, In^{+3}, or Ga^{+3} as coactivator, as well as on self-activated (SA) ZnS and on ZnSe:Cu:Cl. The emission peaks shift to higher energy with increasing pressure, but less strongly than does the absorption edge of the host. The peak intensities decrease rapidly with increasing pressure. The intensity changes could be accounted for quantitatively in terms of the donor—acceptor pair model. The shift of the luminescence peak with respect to the absorption edge is attributed to the pressure coefficient of the donor binding energy E/sub D/. The observed intensity changes with pressure could be related directly to changes in E/sub D/.

1179 High pressure luminescence studies of mixed ZnS—CdS phosphors doped with Cu^+ or Ag^+. House, G.L.; Drickamer, H.G. (School of Chemical Sciences and Materials Research Laboratory, University of Illinois, Urbana, Illinois 61801). **67**: No. 7, 3227-3229(1 Oct 1977).

The effect of pressure has been measured on the emission peak location and emission intensity for a series of phosphors of the form (Zn/sub x/Cd/sub 1-x/)S:Ag:Cl and (Zn/sub x/Cd/sub 1-x/)S:Cu:Cl. The results are qualitatively consistent with the donor—acceptor model. The emission peaks shift to higher energy with increasing pressure but the magnitude of the shift decreases with increasing fraction of Cd. The pressure shift of the absorption edge of CdS is also smaller than that for ZnS. The emission peak shift is always less than the shift of the edge for any given fraction of Cd. Large intensity decreases are observed with increasing pressure for each of the phosphors. The observed intensity changes can be related to changes in the donor binding energy with increasing Cd concentration.

1180 High pressure luminescence studies of localized excitations in ZnS doped with Pb^{2+} and Mn^{2+}. House, G.L.; Drickamer, H.G. (School of Chemical Sciences and Materials Research Laboratory, University of Illinois, Urbana, Illinois 61801). **67**: No. 7, 3230-3237(1 Oct 1977).

High pressure luminescence measurements have been made on ZnS doped with Pb^{+2} and Mn^{+2}. The data include changes in peak energy and shape, integrated intensities, and lifetimes. These localized emissions are treated in terms of a single configuration coordinate model. For Pb^{+2} the emission peak shifted to lower energy by a moderate amount and narrowed. For excitation in the Pb^{+2} absorption the intensity was independent of pressure, which is consistent with the fact that the energy barrier for radiationless return to the ground state was high at all pressures. For excitation in the ZnS absorption edge the intensity decreased significantly with pressure above about 80 kbar. Data on shifts of the conduction band with pressure would indicate that one is approaching a transition from a direct to indirect transition at high pressure so that decrease in emission intensity may be associated with decreased absorption efficiency. The $Mn+^2$ emission peak shifted strongly to lower energy with increasing pressure. The direction and magnitude of the shift were consistent with the predictions of ligand field theory. The intensity doubled in 100 kbar, while the lifetime decreased by roughly a factor of 2. These results could be described in terms of a model for a phonon assisted transition. In addition, peak location, intensity, and lifetime measurements were made on ZnS:Pb:Mn. There is clear evidence of energy transfer by exchange, but in addition there is a nonradiative process in the doubly doped crystal which affects both intensities and lifetimes.

1181 Pressure dependence of the thermodynamical Grueneisen parameter of fluids. Boehler, R.; Kennedy, G.C. (Institute of Geophysics and Planetary Physics, University of California, Los Angeles, California 90024). **48**: No. 10, 4183-4186(Oct 1977).

Temperature changes associated with adiabatic pressure changes have been measured for water, mercury, pentane, isopentane, ethanol, methanol, and ether. For the first four fluids mentioned, the pressure dependence of the adiabatic bulk modulus, K/sub s/, is known from ultrasonic measurements, and the Grueneisen parameter can be calculated using the thermodynamic relationship γ/sub th/= (K/sub s//T)(lT/lP)/sub s/. For all fluids except water a large decrease of ΔT/ΔP with pressure is observed and the ΔT/ΔP curves converge at about 2.5 ^{0}C/kbar before freezing occurs. A considerable increase of γ/sub th/ with pressure is observed.

1182 Ground- and excited-state properties of LiF in the local-density formalism. Zunger, A.; Freeman, A.J. (Department of Physics and Astronomy, and the Materials Research Center, Northwestern University, Evanston, Illinois 60201). **16**: No. 6, 2901-2926(15 Sep 1977).

The band structure, charge density, x-ray scattering factor (and their behavior under pressure), equilibrium lattice constant, and cohesive energy of the prototype ionic solid LiF were determined usng recently developed self-consistent numerical basis set (nonmuffin-tin) linear-combination-of-atomic-orbitals method within the local-density formalism (LDF). The details of the bonding and the effects of exchange and correlation on the electronic structure are discussed with reference to the conventional picture of ionic bonding. Remarkably good agreement is found with the observed data for the ground-state properties of the system. The LDF model is found to account very well for both interband and exciton transitions over the entire spectral region (12—695 eV) and to yield definite predictions regarding the exciton bandwidths and series limits.

1183 Raman scattering from intercalated donor compounds of graphite. Nemanich, R.J.; Solin, S.A.; Guerard, D. (The Department of Physics and The James Franck Institute, The University of Chicago, Chicago, Illinois 60637). **16**: No. 6, 2965-2972(15 Sep 1977).

Raman spectra of vibrational excitations in graphite intercalated with alkali donor atoms have been obtained at room temperature in the backscattering configuration using argon-ion excitation. Stage 1, 2, and 3 cesium donor compounds prepared from highly oriented pyrolytic graphite (HOPG) were studied as were stage 1 and 2 HOPG potassium donor compounds. Second-state cesium and potassium intercalated exhibit a single Raman band unshifted from the E/sub 2g/ intralayer mode of HOPG which occurs at 1582 cm^{-1}. In contrast, the third-stage cesium intercalate produces a doublet spectrum with one component upshifted from and the other at the same position at HOPG intralayer mode. The above described observations for stage-2 and higher-stage donor compounds are explained by an analysis which considers (a) the nearest-layer configurations which a given carbon layer can experience in a given stage of intercalation, (b) the change in C-C bond distance with intercalation, and (c) the effect of intercalation on the carbon interlayer interaction. The spectra of stage-1 cesium and potassium intercalates are almost identical and each contains two anomolously shaped bands, one near to but down shifted from the interlayer mode of HOPG and one at ~ 560 cm^{-1}, both being superposed on a continuum background. These bands are attributed to Breit-Wigner or Fano resonances between an electronic Raman scattering continuum and the E/sub 2g/ intralayer mode and an out of plane

intralayer vibration, respectively. The parameters Γ, q, and Omega-bar governing the Breit-Wigner resonance are determined by fitting the observed line shapes of each of the two bands in the cesium and potassium intercalate spectra.

1184 Experimental study on the cracking behavior of reinforced concrete hollow cylinders subjected to temperature gradient and the assessment of decrease in flexural rigidity due to cracking. Aoyagi, Y.; Onuma, H.; Okazawa, T. (Central Research Inst. of Electric Power Industry, Tokyo (Japan)). No. 376002, 1-5, 1-56(Oct 1976). (In Japanese).

Altough the consideration of thermal stress constitutes one of the primary factors governing the design of the hollow cylindrical structures made of reinforced concrete and subjected to temperature gradient, such as radiation-shielding walls and reactor containment vessels, the method of rationally evaluating the safety margin to such stress has not been established so far. The purposes of the study are to investigate the conditions under which cracks initiate in reinforced concrete structures due to temperature gradient, and to evaluate the decreases in the flexural rigidity after cracking, mainly on the basis of experiment. Three hollow cylinders with top and bottom slabs, 120 cm height and 100 cm outside diameter, were tested. The cylinders were externally cooled by being immersed in water, and internally heated by circulating hot water through the cavities. The maximum temperature difference of 65 deg C was attained. The strain was measured, and the crack patterns were observed. A reinforced concrete beam of 3.8 m length was subjected to temperature difference of 65 deg C. Horizontal cracks appeared first at 27 deg C, and vertical cracks followed at 31 deg C difference at the middle of cylindrical walls. It was assumed that the first cracks appear at the tensile strain of 100 x 10^{-6}, and the calculated result agreed fairly well with the observed temperature difference. The rational method for evaluating the decrease in flexural rigidity due to cracking was proposed by the authors.

CORROSION, EROSION, AND DEGRADATION

1185 Saturation behavior of p-type germanium at CO_2 laser wavelengths. Phipps, C.R. Jr.; Thomas, S.J. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). **1**: No. 3, 93-95(Sep 1977).

Observed bleaching of single-crystal p-type germanium in the 10-μm region obeys an inhomogeneous broadening model for input intensities up to 100 times the saturation intensity I/sub s/. Bleaching measurements show that I/sub s/ varies from about 3.2 MW cm^{-2} at 10.59 μm to about 6.8 MW cm^{-2} at 9.27 μm. No significant variation of I/sub s/ with crystal orientation is seen. Applications to CO_2 laser system isolation are discussed.

1186 Nitrogen isoelectronic trap in GaAs/sub 1-x/P/sub x/: II. Model calculation of the electronic states N/sub Gamma/and N/sub x/ at low temperture. Hsu, W.Y.; Dow, J.D.; Wolford, D.J.; Streetman, B.G. (Department of Physics and Materials Research Laboratory, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801). **16**: No. 4, 1597-1615(15 Aug 1977).

A semiphenomenological theory of the isolated N isoelectronic trap in GaAs/sub 1-x/P/sub x/ is presented, based on an extended (multisite), one-band Koster-Slater model of the electron-impurity interaction, including the effects of both the central-cell atomic pseudopotential difference and the spatially extended lattice distortion surrounding the substitutional nitrogen impurity. The alloy host is treated in a virtual-crystal approximation. The parameters of the model are determined by fitting low-temperature photoluminescence data from ion-implanted materials of two compositions selected near x ≃ 0.35. The model yields both a spatially localized N/sub X/ (or A) state which evolves continuously with decreasing x from the A line of GaP, and a spatially-diffuse state N/sub Gamma/ which is present in near-direct and direct-band-gap alloys (0.3 9 or ≃ x 9 or ≃ 0.5). The theory quantitatively describes the energies of these luminescence lines as a function of alloy composition x. In addition, good agreement with the data is found for the following calculated quantities: (i) the composition dependences of the N/sub Gamma/and N/sub X/ luminescence intensities, (ii) the pressure dependences of the N/sub Gamma/and N/sub X/ intensities, (iii) the composition dependence of the N/sub X/ lifetime, and (iv) the binding energy of NN_1 pairs in GaP. The model leads to a tentative interpretation of N/sub Gamma/luminescence as originating, at least in part, from excitonic molecules.

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 334

1187 (AD-A—039774) Displacement damage in silicon irradiated with 6- to 10-MeV neutrons. Memorandum report. Youngblood, J.E.; Van Antwerp, W.R.; Tapphorn, R.M. Apr 1977. 36p. (BRL-MR—2738). NTIS PC A03/MF A01.

Some preliminary experimental and theoretical results on the energy dependence of neutron-induced displacement damage in silicon are presented. The reduction in carrier lifetime, as reflected in the change in forward voltage at a fixed injection level, has been measured in wide-base silicon diodes, for monoenergetic neutrons at selected energies between 5.6 and 9.8 MeV. Twenty-five measurements at 19 energies were made. To calculate the variations in damage with neutron energy, a computer program that could utilize all details of the best available neutron cross section data was prepared. This program accepts coefficients for a Legendre polynomial fit of a partial cross section, determines the silicon recoil energy at a particular angle, and calculates the Lindhard fraction of energy for displacement damage. The calculated results provide a direct indication of the effect of angular distributions and the sensitivity of damage calculations to various details of the input neutron cross sections. (Author)

1188 (AD-A—039947) Effects of low-temperature neutron irradiation on arsenic-doped silicon. Final report 1 Apr 1975—30 Sep 1976. Kalma, A.H.; Fischer, C.J. Feb 1977. Contract F19628-75-C-0138. 78p. (INTEL-RT—8129-007). NTIS PC A05/MF A01.

Arsenic-doped silicon material obtained from LWIR detector manufacturers (Aerojet and Rockwell) or a supplier of these manufacturers (High Performance Technology) was irradiated with neutrons at 10K, and the optical response and electrical properties were measured. The material was of the grade from which quality LWIR detectors could be fabricated. The primary effect of irradiation was the net introduction of acceptor centers at a rate of approximately 16/cm. This introduction rate was independent of oxygen concentration in the material, but its dependence on arsenic or acceptor concentration was not determined in this program. The primary effect of the radiation-induced acceptors is to compensate the arsenic levels, which decreases the majority-carrier lifetime and thus the responsivity. The acceptors also decrease the carrier concentration at low temperature. Irradiation-induced mobility changes are relatively slight, apparently the low-temperature mobility prior to irradiation is primarily set by neutral impurity scattering. Some band tailing is produced by the radiation, but this is unstable and anneals to a large extent by 100K. It is replaced by a short-wavelength depression (or a long-wavelength enhancement) in the spectral response, which may be another manifestation of the same defects. In general, the damage effects were quite stable, and few changes were observed in the measured properties up to annealing temperatures of 400C.

1189 (AD-A—041264) Preliminary investigation of mechanical responses of fiber optics to nuclear radiation. Final report. Tucker, J.C.; Soda, K.J.; Mardiguian, A.E. Jun 1977. 35p. (AFWL-TR—76-291). NTIS PC A03/MF A01.

Four generic types of optical fibers which have low optical responses to nuclear radiation were evaluated to detect any significant radiation-induced mechanical changes. Bend radius, flexure, mandrel strength, tensile strength and thermal cycling tests were performed. Fiber responses in tensile and bending qualities were observed; but while the changes should probably be considered in application engineering, they are not significant in disqualifying any fiber from use in radiation environments.

1190 (AD-A—041465) Calculated energy dependence of neutron induced displacement damage in silicon. Memorandum report. Youngblood, J.E.; Van Antwerp, W.R. Jun 1977. 50p. (BRL-MR—2759). NTIS PC A03/MF A01.

The results of calculations on the energy-dependence of neutron-induced displacement damage in silicon are presented. A computer code that utilizes all available neutron cross section information has been used to calculate the energy available for displacement damage, according to Lindhard theory, in 5 keV intervals. Tables of results averaged over 25 keV intervals and averaged over 100 keV intervals are also presented.

CHEMISTRY

1191 Decomposition theory of chemical reactions. Rabitz, S.; Rabitz, H. (Department of Chemistry, Princeton University, Princeton, New Jersey 08540). **67**: No. 7, 2964-2973(1 Oct 1977).

The coupled channel formulation is utilized to variationally derive approximate closed-form expressions for reactive transition matrices. In conjunction with this effort it is shown that the effect of differing choices of possible channel coupling arrays becomes important when incomplete channel basis sets are used. Generalized techniques are employed to derive the necessary variational principles. The inherent coupling of the Green's functions in the resulting expression for the transition matrix makes inclusion of continuum states in the basis sets less crucial. The practical viability of this

formulation as a computational scheme for chemical systems is discussed.

ANALYTICAL AND SEPARATIONS CHEMISTRY

REFER ALSO TO CITATION(S) 1343, 1359

1192 (RDT-F—11-2T(7-77)) **Analytical chemistry methods for boron carbide absorber material.** Jul 1977. Contract EY-76-C-14-2170. 114p. .

This standard provides analytical chemistry methods for the analysis of boron carbide powder and pellets for the following: total C and B, B isotopic composition, soluble C and B, fluoride, chloride, metallic impurities, gas content, water, nitrogen, and oxygen. (DLC)

ACTIVATION AND NUCLEAR REACTION PROCEDURES

REFER ALSO TO CITATION(S) 1339

1193 (AD-A—040061) **A comparative evaluation of the neutron/gamma and Kelly-Vail techniques for determining water and cement content of fresh concrete. Final report.** Howdyshell, P.A. May 1977. 167p. (CERL-SR-M—216). NTIS PC A08/MF A01.

The objective of this investigation was to comparatively evaluate a nuclear (neutron/gamma) technique and a chemical (Kelly-Vail) technique determining water and cement content of fresh concrete. The nuclear technique relies on the characteristic energy emissions of various elements during neutron interactions for determining water and cement content. The chemical technique relies on chloride ion titration to determine water content and flame photometry to determine cement content. Tests results indicate that the neutron/gamma method can estimate water contents to + or - 6 percent, and cement contents to + or - 9 to 22 percent, depending on the type of aggregate used. This compared to cement and water content accuracies of 7.1 and 5.2 percent, respectively, for the chemical technique.

1194 **Use of nuclear reactions and SIMS for quantitative depth profiling of hydrogen in amorphous silicon.** Clark, G.J.; White, C.W.; Allred, D.D.; Appleton, B.R.; Magee, C.W.; Carlson, D.E. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). **31**: No. 9, 582-585(1 Nov 1977).

Depth profiles for hydrogen in amorphous silicon have been determined by the use of resonant nuclear reactions [$^{1}H(^{15}N,\alpha\gamma)^{12}C$ and $^{1}H(^{19}F,\alpha\gamma)^{16}O$] and by secondary ion mass spectroscopy (SIMS). Independent calibration procedures were used for the two techniques. Measurements were made on the same amorphous silicon film to provide a direct comparison of the two hydrogen analysis techniques. The hydrogen concentration in the bulk of the film was determined to be about 9 at.% H. The SIMS results agree with the resonant nuclear reaction results to within 10%, which demonstrates that quantitative hydrogen depth profiles can be obtained by SIMS analysis for materials such as amorphous silicon.

CHEMICAL PROCEDURES

REFER ALSO TO CITATION(S) 1193, 1421

RADIOMETRIC AND RADIOCHEMICAL PROCEDURES

REFER ALSO TO CITATION(S) 108, 1347, 1509

1195 **Nondestructive method for measuring of uranium 235 and plutonium 239 amount using neutron transmission.** Filippov, V.V.; Petrov, V.L. **17**: No. 5, 837-841(1975). (In Russian).

From Conference on neptunium and plutonium chemistry; Leningrad, USSR (25 Mar 1975).

For English translation see the journal Sov. Radiochem.

Owing to the specific nature of the resonance structure of total neutron cross sections of certain isotopes it is possible to obtain information about the composition of an isotopic mixture by passing a beam of neutrons through the sample. This approach has been used in developing an analytical nondestructive control method. The law of diminishing intensity of the beam passing through calibrated filters of increasing thickness makes it possible to register the presence of ^{239}Pu or ^{235}U, beginning with concentrations 3 and 20 mg/cm^2 respectively. The method is especially effective for measuring the amount of ^{239}Pu in the absence of a similar ^{235}U isotope or vice versa. In this case the concentrations of ^{239}Pu and of ^{235}U can be determined with an accuracy of about +-1% for samples containing respectively 0.3-2.5 and 2.16 g/cm^2. The composition of a U-Pu mixture can be determined with a somewhat lesser degree of accuracy.

1196 **Using high energy gamma sources for coal ash content control.** Komova, E.N. (Moskovskij Gornyj Inst. (USSR)). No. 1, 3-5(1976). (In Russian).

2 refs.; 3 figs.

The method is based on two effects, viz. multiple diffraction of γ-quanta from a ^{137}Cs source and their subsequent absorption due to a photoeffect. Investigation results are given on the choice of optimum geometry of measurements and spectrum energy region with regard to coal ash content.

SPECTRAL PROCEDURES

1197 (IS-M—85) **Current and potential applications of inductively coupled plasma (ICP)-atomic emission spectroscopy (AES) in the exploration, mining, and processing of materials.** Fassel, V.A. 24 Aug 1976. Contract W-7405-ENG-82. 14p. (CONF-7608100—2). Dep. NTIS, PC A02/MF A01.

From International symposium of analytical chemistry in the exploration, mining and processing of materials; Johannesburg, South Africa (23 Aug 1976).

The first papers describing the potential advantages of using inductively coupled plasmas as vaporization-atomization-excitation sources for the atomic emission determination of the elements appeared in the literature approximately ten years ago. During the elapsed decade, continuing studies in a relatively small number of laboratories have led to striking advances in the scope of application of this analytical concept. With state of the art systems, it is now possible to determine all of the metals, metalloids, noble gases, and hydrogen at the major, minor, trace, and ultratrace level in a viable practical manner. In principle, all of these elements can be detected and determined simultaneously or sequentially under a single set of operating conditions. In this review the formation and the properties of these plasmas are summarized and the present capabilities of ICP-AES with reference to such figures of merit as powers of detection, simultaneous multielement capability, applicability to the analysis of microliter or microgram samples, interelement effects, applicability to the direct excitation of liquids, solids, and gases, cost, accuracy, precision and dynamic range are reviewed. 41 references.

1198 **Metals associated with organic carbon extracted from Okefenokee Swamp water.** Giesy, J.P. Jr.; Briese, L.A. (Savannah River Ecology Lab., Aiken, SC). **20**: No. 2, 109-120(Aug 1977).

Organic C from Okefenokee Swamp water was fractionated into four nominal diameter fractions, using membrane ultrafiltration and concentrations of ten metals associated with each fraction determined using flameless atomic absorption. Total organic C (TOC) concentration was 39.5 mg/l with more than 70% of the TOC in the fraction passing through the 0.0009-μm ultrafilters. Approximately 26% of the TOC was retained by a 0.0032-μm membrane and less than 4% was in two larger fractions. Most of the Ca, Cu, Cr, Mg, Mn, and Ni was in the smaller fractions, while Fe and Pb were associated with the largest fraction (40 greater than or equal to F greater than or equal to 15μm). Cd and Zn had the greatest percentage approximately equally distributed between the largest and smallest fractions. All metals except Ca had higher metal/organic C ratios in the larger fractions.

1199 **Mass spectrometric determination of gases in individual coated HTR fuel particles. I. Set-up, procedure and performance.** Strigl, A.; Bildstein, H. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Inst. fuer Chemie). **142**: No. 3, 507-512(1 May 1977).

A method is described which allows the simultaneous determination of fission and reaction gases in individual coated particles at temperatures up to 2 000°C. The particles are heated under high-vacuum in a micro resistance-furnace up to the desired temperature. After preselected times the particles are crushed by action of a pneumatic cylinder. The gases liberated are fed into a quadrupole analyzer where they are analyzed in a dynamic mode. A peak selector allows the simultaneous measurement of up to four gases. The method is used routinely for the determination of fission gases (Kr and Xe) and of carbon monoxide which is formed as a reaction gas from oxide fuel. Precision and accuracy are in the order of a few percent. Detection limits for routine measurements are about 10^{-7} cm^3 (STP) for Kr and Xe and $2x10^{-5}$ cm^3 (STP) for CO but can be lowered by special techniques.

1200 **Mass-spectrometric determination of gases in individual coated HTR fuel particles. II. Optimum choice of heating and crushing conditions.** Strigl, A.; Proksch, E. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Inst. fuer Chemie). **142**: No. 3, 513-519(1 May 1977).

In a previous paper, an apparatus has been described for the mass-spectrometric determination of fission and reaction gases in HTR fuel particles. The present paper summarizes investigations made with respect to the influence on the results of certain parameters. Prior to analysis, the particles have to be heated. It could be shown that it is advisable (for the determination of the rare gases) or even necessary (to obtain meaningful CO results) to choose a heating

temperature as close as possible to irradiation temperature. Optimum heating times are in the order of minutes for the rare gases and 24 h for CO. However, the latter can be used as an acceptable compromise also when simultaneous determination of CO and the rare gases is desired. After 24 h the heating should be stopped for about 10 s and finally the whole particle should be crushed mechanically as completely as possible.

1201 Spectrophotometric determination of uranium(VI) with benzyol-m-nitroacetanilide and application to uranium ores. Mandal, S.K.; Chaudhuri, N.K.; Das, J. (Burdwan Univ., West Bengal (India). Dept. of Chemistry). **53**: No. 7, 685-687(Jul 1976).
13 refs.

The yellow coloured UO_2^{2+}-bis-benzoyl-m-nitroacetanilide complex was extracted in isobutylmethyl ketone from solutions of Ph 5.5 to 7.0 and the metal was determined by measuring the absorbance of the extract at 395 nm (for 50-300μg of U) or at 415 nm (U, above 300 μg) with relative standard deviation of +- 1.01%. The presence of Ag^+ and Tl^+ did not interfere while magnesium-EDTA was used to mask Pb^{2+}, Bi^{3+}, Cu^{2+}, Cd^{2+}, Al^{3+}, Ga^{3+}, In^{3+}, Cr^{3+}, Fe^{3+}, Ni^{2+}, Ba^{2+}; Sr^{2+}, Ce^{3+}, Th^{4+}, VO^{2+}, MoO_4^{2-}, and CrO_4^{2-}. For Co^{2+}, Be^{2+} and Zr^{4+} sulphosalicylic acid was used as the masking agent and iodide for Hg^{2+}. The uranium content of several ores containing 2-25 percent of this metal has been determined with an average relative error of +- 1.3%. The dissociation constant of the complex was found to be 1.53×10^{-12}.

SEPARATION PROCEDURES

1202 (ORNL/TM—5921) **Literature review of nitrogen oxide absorption into water and dilute nitric acid.** Counce, R.M. Aug 1977. Contract W-7405-ENG-26. 30p. .

The removal of gaseous nitrogen oxides from off-gas streams is important when reprocessing spent nuclear fuels. The absorption of nitrogen oxides has been the subject of several laboratory and engineering-scale experiments and the theory of nitrogen oxide absorption seems to be well established. However, previous engineering-scale experimental work is not directly applicable to proposed nitrogen oxide removal processes. A literature survey has been conducted to determine the "state of the art" in nitrogen oxide absorption. The purpose of this report is to give the results of that survey and make some general observations on nitrogen oxide absorption.

INORGANIC AND PHYSICAL CHEMISTRY

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 1606

1203 (AD-A—039684) **The tungsten-to-tungsten triple bond. 7. Replacement of dimethylamido by chloro groups in hexakis (dimethylamido)ditungsten and -dimolybdenum compounds; the preparation, properties and structure of dichlorotetrakis-(dimethylamido)ditungsten and -dimolybdenum. Technical report.** Akiyama, M.; Chisholm, M.H.; Cotton, F.A.; Extine, M.W.; Murillo, C.A. 13 May 1977. Contract N00014-76-C-0826. 32p. NTIS PC A03/MF A01.

$M_2(NMe_2)_6$ compounds (M = MO,W) react with Me_3SiCl (2 equiv) in hydrocarbon solvents to give $M_2Cl_2(NMe_2)_4$ and Me_3SiNMe_2. An amine catalyzed reaction sequence is proposed: (1) $HNMe_2 + Me_3SiCl$ yields $Me_3SiNMe_2 + HCl$ (II) M-NMe_2 + HCl yields M-Cl + $HNMe_2$. This sequence is supported by the observations that $W_2(NMe_2)_6$ does not react with Me_3SiCl in the absence of amine and that $W_2Cl_2(NMe_2)_4$ reacts rapidly with $HN(CD_3)_2$ to give $W_2(NMe_2)_6$ with complete scrambling of dimethylamine. In solution $W_2Cl_2(NMe_2)_6$ and $W_2Cl_2(NMe_2)_6$ exist in equilibrium with $W_2Cl(NMe_2)_5$ (K approx. 1 at 30 C). The compounds $M_2Cl_2(NMe_2)_4$ have been characterized by variable temperature NMR studies, infrared and mass spectroscopy and single crystal X-ray crystallography.

1204 (AD-A—039765) **Vibrational spectra of transition metal hexafluoride crystals. I. Orthorhombic MoF6, WF6, UF6 neat crystals. Technical report.** Bernstein, E.R.; Meredith, G.R. Apr 1977. Contract N00014-75-C-1179. 43p. (TR—12). NTIS PC A03/MF A01.

Neat crystal Raman spectra of orthorhombic MoF6, WF6, and UF6 are presented and discussed. The neat crystal spectra are interpreted in terms of an internal-external mode separation and a conventional factor group analysis. In general, these data lead to four essential conclusions concerning hexafluoride crystals: (a) Fermi resonance plays an important role in producing the observed energy and intensity differences in this series; (b) k = 0 exciton structures are remarkably similar in the three crystals; (c) similarities and differences between these solids can be directly correlated with molecular parameters such as dipole derivatives, polarizabilities, etc.; and (d) phonons (external modes) can be neatly separated into rotational and translational normal modes.

1205 (SAND—76-0556) **Preparation and structural studies of the hydrolysis products of titanium, niobium and zirconium alkoxides.** Peercy, P.S.; Dosch, R.G.; Morosin, B. Jul 1977. Contract EY-76-C-04-0789. 35p. Dep. NTIS, PC A03/MF A01.

Raman scattering, analytical and x-ray techniques were used to investigate the structural units in amorphous hydrolysis products of the alkoxides of Nb, Ti and Zr and in the corresponding sintered materials. These materials are used for ion exchange in the proposed radioactive waste disposal process. The starting solution for the Nb system yielded crystals containing $(Nb_{10}O_{28})^{6-}$ ions as the basic structural unit; however, this form for the polyniobate ion was not observed in any other stages of the synthesis or in any phase of the ion exchange material after sintering. The two crystalline phases of the Nb ion exchange material which occur on sintering were determined to be $Na_2Nb_4O_{11}$ and $Na_{13}Nb_{35}O_{94}$. No stable crystals have been obtained for the initial Ti and Zr compounds so the initial ionic configurations could not be determined. Upon sintering, the Ti ion exchange material exhibits four crystalline phases. The structure and ionic configuration of the two higher temperature phases were determined to be $Na_2Ti_3O_7$ and $Na_2Ti_6O_{13}$. In contrast, the Zr ion exchange material initially crystallizes in a cubic stabilized zirconia phase and at higher sintering temperature the structure converts to the monoclinic baddeleyite phase of ZrO_2. For each of the systems the only truly amorphous phase encountered was the final ion exchange material. 2 figures.

1206 Accurate characterization of the transition state geometry for the HF+H'→H+H'F reaction. Wadt, W.R.; Winter, N.W. (Theoretical Division, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). **67**: No. 7, 3068-3073(1 Oct 1977).

The potential surface for the exchange reaction HF+H'→H+H'F has been investigated with various multiconfiguration self-consistent field (SCF) and configuration interaction (CI) wavefunctions. For the first time, nonlinear geometries have been considered. The calculations demonstrate the importance of diffuse functions on the fluorine for describing nonlinear geometries. A qualitative model is presented to explain the need for diffuse functions. The energy barrier for the exchange reaction is calculated to be ~45 kcal/mole, which is comparable to the values obtained in previous ab initio calculations on the collinear reaction surface (Refs.1 and 2). More importantly, the calculations show that the saddle point region is very flat, the barrier changing by only 1—2 kcal/mole between collinear (180°) and perpendicular (90°) geometries. The optimum angle for the transition state geometry is calculated to be 106°. Dynamics calculations on the HF+H'→H+H'F reaction have employed semiempirical London—Eyring —Polanyi—Sato (LEPS) surfaces that had artifically small energy barriers, as has been pointed out previously. The present calculations show that not only were the barriers for exchange too low, but that the basic shape of the LEPS surfaces was inappropriate. The implications of this result for future dynamics calculations are discussed.

1207 Mechanisms of chemical oscillators: experimental examples. Noyes, R.M. (Univ. of Oregon, Eugene); Field, R.J. **10**: No. 8, 273-280(Aug 1977).

A number of chemical systems that exhibit temporal or spatial periodicities are discussed. The classic acid bromate oxidation of organic compounds catalyzed by cerous or manganous ions is discussed very briefly as the most studied and best understood chemical oscillators. The oscillating systems of the acidic iodate and hydrogen peroxide is discussed briefly, and work involving the addition of manganous ion and malonic acid to the acidic iodate-hydrogen peroxide system for a dramatic enhancement of the oscillations is cited. The oscillatory evolution of gas from the decomposition of formic acid by sulfuric acid reported over 60 years ago and recently reexamined is reviewed. Small additions of formaldehyde, sodium nitrite, or ferrous sulfate are reported to grossly affect the kinetic behavior of this decomposition. Other chemical oscillating systems cited are the autocatalytic disproportionation of aqueous dithionite and the irreversible chemical process resulting from the uv irradiation of 1,5-napthyridine. Oscillatory electrode reactions, periodic precipitation phenomena, and oscillations during gas reactions are discussed. Some oscillations observed in biological systems are mentioned, but not explained. Several characteristics of these known chemical oscillators are summarized. (BLM)

1208 Fuzzy interface between surface chemistry, heterogeneous catalysis, and organometallic chemistry. Schaefer, H.F. III. (Univ. of California, Berkeley). **10**: No. 8, 287-293(Aug 1977).

Data from various previously reported works in the fields of surface chemistry, heterogeneous catalysis, and organometallic chemistry are cited to serve as a foundation for the development of a hypothesis to explain the interrelation of these three areas of study. The simplest possible interface between the three areas is illustrated, and this cited system provides a testing ground for molecular theories of catalysis. It is concluded that all three fields have a common

denominator in the reacting bonded species which can be denoted as M-OF where M = transition metal and OF = organic fragment. (BLM)

1209 (ORNL-tr—4446) **Questions of water dechlorination (the amount of hyposulfite needed to dechlorinate water).** Al'terman, N.A. Translated by S.D. Blalock Jr. from **23**: No. 6, 66-67(1958). 3p. Dep. NTIS, PC A02/MF A01.

The amount of hyposulfite necessary to neutralize chlorine depends significantly on pH of the water. It increases proportional to the decrease in pH. The rate of use of hyposulfite used for water dechlorination can be reduced from 3.5 to 1.6-2.8 mg depending on pH. When it is impossible to determine pH, the maximum rate of using hyposulfite will be 2.8 mg.

1210 **Mode of transition from Hagg iron carbide to cementite.** Cohn, E.M.; Hofer, L.J.E. **72**: 4662-4664(1950).

The reaction of Haegg carbide, Fe_5C, to yield cementite, Fe_3C, and free carbon is a discontinuous or heterogeneous precipitation. Haegg carbide and cementite have narrow ranges of composition and apparently do not form intermediate metastable solid solutions. The reaction $3Fe_5C$—Haegg $\rightarrow 2Fe_3C + C$ becomes appreciable only at about 450°, while the reaction Fe_5C—Haegg + Fe $\rightarrow Fe_3C$ starts below 300°. The "unstable" or "labile" carbide of Koelbel and co-workers is simply Haegg carbide.

1211 (BNWL-tr—259) **Study of partial pressures of NH_3, CO_2, and H_2O over aqueous solutions of ammonium carbamate at 140 to 200°C (report 3).** Bolotov, B.A.; Leman, V.R. Translated from **17**: No. 1, 28-32(1940). 19p. Dep. NTIS, PC A02/MF A01.

Based on the data produced on the study of partial pressures of NH_3, CO_2 and H_2O over aqueous solutions of ammonium carbamate at high temperatures, the following conclusions can be drawn: (1) For solutions with NH_3:CO_2 ratios of 2:1, as the temperature rises to 200°C, a sharp increase is noted in the CO_2 vapor pressure with a slight increase in the NH_3 vapor pressure. (2) An increase in the solution concentration from 50 to 200 g/l NH_3 also leads to a significant increase in the partial pressure of CO_2, but has little influence on the NH_3 vapor pressure. (3) The addition of NH_4NO_3 to solutions of ammonium carbamate greatly increases the CO_2 vapor pressure, although an increase in the NH_3 vapor pressure is observed as well, leading to a decrease in the CO_2:NH_3 ratio in the gas. (4) The distillation of aqueous solutions of ammonium-carbon salts at NH_3:CO_2 = 2:1 and at temperatures of 160 to 200°C can be used to separate from the solutions up to 80 percent of the CO_2 in compressed form at up to 60 to 70 atm.

1212 (BNWL-tr—258) **Rate of absorption under bubbling conditions.** Shabalin, K.N.; Krylov, S.F.; Oborin, V.I. Translated from **16**: No. 1, 10-14(1939). 20p. Dep. NTIS, PC A02/MF A01.

Adsorption was studied under conditions of gas bubbles rising through a fluid. Circulation inside the gas bubble and the rise rate of the bubble in the liquid are discussed. Mathematical forms are developed for the process of adsorption under these conditions. An equation and a universal graph are derived. The correctness of these equations are confirmed by observations on ammonia--water vapor bubbles and on carbon dioxide in water. The adsorption rate coefficient is practically constant and independent of bubble size. This indicates intensive convection inside the liquid and inside the gas bubble. (DLC)

ISOTOPE EXCHANGE AND ISOTOPE SEPARATION

1213 **Deuterium isotope enrichment in methane-hydrogen mixtures subjected to a low-temperature glow discharge.** Manuccia, T.J.; Geosling, C.E. (Naval Research Laboratory, Washington, D. C. 20375). **31**: No. 9, 575-577(1 Nov 1977).

Significant enrichment of deuterium has been demonstrated in flowing CH_4-H_2 mixtures subjected to a low-temperature glow discharge. In the best case, over 500% enrichment per stage was measured. A pronounced translational temperature effect was observed with the optimum enrichment occurring at T/sub wall/=-105 °C.

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 1208

RADIATION CHEMISTRY

REFER ALSO TO CITATION(S) 59, 1222, 1223, 1224

1214 **Reactions of iodine with olefins. IV. Preferential site attack of electrophilic high energy iodine in gaseous, high pressure, and liquid butene-1.** To, K.C.; Berg, M.E.; Rack, E.P. (Univ. of Nebraska, Lincoln). **81**: No. 13, 1239-1245(30 Jun 1977).

Reactions of high energy iodine with butene-1 have been found to yield six organic products. Additive studies show that of 21.4 percent total organic product yield at 1 atm, the majority is the result of high energy reactions, many radical in nature. The gas to condensed phase transition shows a typical rise in all organic products except vinyl iodide. Analysis of all available data suggests that the products formed in the reactions of iodine with butene-1 arise from a diverse and complex series of product formation routes; however, greater than 70 percent of the organic products formed at 1 atm are the result of preferential site attack by iodine at or near the double bond.

1215 **Measurement of the activation energy for the reaction of the hydroxyl radical with hydrogen in aqueous solution.** Schmidt, K.H. (Argonne National Lab., IL). **81**: No. 13, 1257-1263(30 Jun 1977).

The rate constant, k_1, for the reaction $OH + H_2 \rightarrow H_2O + H$ in aqueous solution was measured at temperatures between 15 and 90°C. This was achieved by using a new signal averaging technique, combined with a flow system, to record the transient absorption of the OH radical during repetitive pulsing of the solution with the electron beam from a linear accelerator. From the data, the activation energy, E/sub a/, for the above reaction was calculated. The results, with their 90 percent confidence limits, are k_1 (25°C) = 3.96 x 10^7 L mol^{-1} s^{-1} +- 10 percent and E/sub a/ = 3.18 +- 0.5 kcal mol^{-1}.

1216 **Evidence for spur overlap in the pulse radiolysis of water.** Fanning, J.E. Jr.; Trumbore, C.N.; Barkley, P.G.; Olson, J.H. (Univ. of Delaware, Newark). **81**: No. 13, 1264-1268(30 Jun 1977).

The kinetics of the decay of hydrated electron absorbance in pure water has been studied as a function of time and radiation dose delivered by 20-ns pulses of 15-MeV electrons. In order to identify intraspur reactions of the hydrated electron, values of the function ([-d(e/sub aq/⁻)/(e/sub aq/⁻)]/dt)/sub t/ (identical with Q/sub t/) were investigated as a function of pulse dose and time. Q/sub t/ represents the fraction of hydrated electrons disappearing at any given time, t, following the pulse. Whereas Q has the same functional form as a first-order rate constant, it is not a constant, but decreases with increasing time following the pulse. However, the functional form of Q/sub t/ vs. time remains the same at low pulse doses (37 - 380 rads) for relatively long periods of time (up to 1 μs). The dose independence of Q is interpreted as evidence for predominantly intraspur hydrated electron decay. A plot of Q/sub t/ vs. the function [(time)/sup 1/2/(dose)/sup 1/3)] yields a relatively sharp transition from dose independent hydrated electron decay (interpreted as arising predominantly from intraspur reactions) to dose dependent decay (both interspur and intraspur decay). This transition region is interpreted as the onset of significant spur overlap. In the range 0-8000 rads per 20-ns pulse, an empirical constant: (approximate time of detectable overlap)/sup 1/2/ (dose)/sup 1/3/ = 110 +- 10 ns/sup 1/2/ rads/sup 1/3/ is obtained which correlates the onset of experimentally observable spur overlap. Based upon these results, implications regarding spur sizes and spatial distributions of spurs and the need to include spur overlap considerations in modeling studies are developed.

1217 **Kinetics of radical decay. IV. Polycrystalline p-azoxyanisole.** Tria, J.J.; Johnsen, R.H. (Florida State Univ., Tallahassee). **81**: No. 13, 1274-1278(30 Jun 1977).

Free radical decay in x-irradiated powder samples of p-azoxyanisole (PAA) studied between 60°C and the liquid crystal phase transition at 118°C was observed to occur in a "stepwise" manner with no evidence of radical conversion. Of several models tested the data were best fit by a kinetic equation due to Waite which involves a random initial spatial distribution of radicals, an activation energy for radical combination, E/sub comb/, which dominates at early time, and an activation energy for diffusion, E/sub diff/, which dominates at late times. Application of the model to the data yields E/sub comb/ = 9.6 and E/sub diff/ = 19.3 kcal/mol. The activation energies correspond well to those reported by other workers from NMR measurements of rotational and diffusional motion in PAA. The model also allows estimation of the diffusion coefficient provided r_0 in the kinetic equation can be approximated. Taking r_0 as the largest lattice dimension (20.5 A) one obtains a value of D approximately equal to 1 x 10^{-10} cm^2/s at 0.96 of the phase transition temperature. Such considerations lead to the assignment of E/sub diff/ to an extrinsic, defect controlled diffusion process and E/sub comb/ to a rotation of the radical about the long molecular axis necessary to reach a favorable orientation for combination with another radical. The general role of radical shape and ease of rotation in influencing the decay kinetics is discussed.

1218 **Kinetics of radical decay. V. Single crystal n-alkoxyazoxybenzenes.** Tria, J.J.; Johnsen, R.H. (Florida State Univ., Tallahassee). **81**: No. 13, 1279-1284(30 Jun 1977).

Decay kinetics of free radicals produced by x-radiolysis of single crystal samples of three members of the homologous series of n-dialkoxyazoxybenzenes has been studied in the range between

room temperature and the solid-to-liquid crystal phase transition temperature. Radical decay was analyzed using a model due to Waite which assumes a random initial spatial distribution of radicals and separate activation energies for radical diffusion and recombination. In single crystal samples the activation energies (in kcal/mol) were 23 and 34 for p, p'-azoxyanisole (PAA), 17 and 40 in p,p'-azoxyphenetole (PAP), and 19 and 31 in heptyloxyazoxybenzene (HAB) for combination and diffusion, respectively. The activation energy for combination is attributed to a rotational reorientation of the radicals. The activation energy for diffusion is attributed to an intrinsic bulk self-diffusion process, in contrast to the grain boundary diffusion process previously reported for radical decay in polycrystalline PAA. The effect of changing length of the alkoxy group on the activation energies is discussed. A solid-solid phase transition was discovered at 91°C in PAP. Radicals in solvent-grown crystals decayed rapidly at the transition temperature, while radicals in samples which had been annealed above the transition temperature before irradiation showed normal decay behavior.

1219 Recent advances in the theories of carbon dioxide radiolysis and radiolytic graphite corrosion. Wickham, A.J.; Best, J.V.; Wood, C.J. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). **10**: No. 2, 107-117(1977).

An understanding of the radiation chemistry of CO_2-CO-graphite systems is of fundamental importance in gas-cooled reactor technology. The radiation chemistry of gas-phase CO_2 is reviewed in terms of the extensive positive ion cluster chemistry which has been observed in drift-tube studies of ions generated by an integral α-source. These very rapid processes, which have been confirmed in conventional drift tube studies, enable a new theory to be advanced to account for the apparent stability of CO_2 under irradiation. The stable ions in the system are $(CO_2)_2^+$ and CO_3^-, and when traces of CO are present, $(CO)_2^+$ and $(CO_2.CO.CO)^+$. A mechanism, consistent with this ion chemistry, for the oxidation of graphite by irradiated CO_2 is proposed in which the oxidating species are positively charged and contain the CO_2 molecule. A need for further work upon gas-phase and surface ion neutralization processes is identified. The effects of added CO in both gas-phase systems and in graphite attack may be accounted for, but areas of uncertainty remain in explaining the difference between the yield of the isotope exchange reaction $^*CO + CO_2 = CO + {}^*CO_2$ and the ion yield in such systems. The complex effects of oxygen, sulfur hexafluoride and important impurities of reactor coolants such as methane, while much clarified in terms of the new theory, require further work to obtain a complete understanding of their behavior in the CO_2-CO-graphite system.

1220 New insights on the thermal decomposition of ammonium perchlorate from studies on very large single crystals. Herley, P.J. (State Univ. of New York, Stony Brook); Levy, P.W. pp 355-360 of In Reactivity of solids. Wood, J.n (ed.). New York; Plenum Press (1977).

Crystals larger than 2 to 3 mm were either thermally decomposed or γ-irradiated and then examined by optical, scanning, and transmission electron microscopy. Results show that the reaction largely occurs on the c-face and only partially on the m-face. Retentions of 70 to 96% are often observed. A possible reaction mechanism is suggested. (DLC)

RADIOCHEMISTRY AND NUCLEAR CHEMISTRY

HOT-ATOM CHEMISTRY

REFER ALSO TO CITATION(S) 1601

1221 Kinetics and mechanism of recoil chlorine atom reactions with ethylene. Stevens, D.J.; Spicer, L.D. (Univ. of Utah, Salt Lake City). **81**: No. 13, 1217-1222(30 Jun 1977).

Addition and abstraction are the major reactions observed between nuclear recoil generated chlorine atoms and ethylene. The addition reaction is characterized, and its relative efficiency is determined for low energy chlorine in systems containing H_2 and C_3F_6 as competitive reactants. At low pressures, the unimolecular kinetics of an addition-decomposition process yielding HCl are examined, and the relative translational energy of the chlorine atoms which initiate that reaction is estimated. Hydrogen abstraction from ethylene is also explored in this system and found to be predominantly a low energy process in competition with addition. In the limits of high pressure and high moderation, the rate ratio of addition to abstraction for low energy chlorine atoms with ethylene is found to be 15.5 +- 0.5. Results for competitive addition reactions between C_2H_4 and C_3F_6 yield a rate ratio of 16 +- 2 favoring ethylene. The only additional reaction observed in pure ethylene corresponds to carbon-carbon bond scission and accounts for less than 1 percent of the total yield.

1222 Thermal ^{38}Cl reactions with propene. Lee, F.S.C.; Rowland, F.S. (Univ. of California, Irvine). **81**: No. 13, 1222-1229(30 Jun 1977).

Thermal ^{38}Cl atoms react with gaseous propene at 20°C by terminal addition to form $CH_3CHCH_2{}^{38}Cl$ and by central addition to form $CH_3CH^{38}ClCH_2$. These two processes account for 86 +- 4 percent of the available thermal ^{38}Cl, with the remainder presumably reacting by abstraction of the allylic hydrogen to form $H^{38}Cl$. Both radicals are able to decompose by loss of ^{38}Cl or to be stabilized by collision with $CClF_3$, with the two processes equally likely at 150 +- 50 Torr pressure. The ^{38}Cl atoms are produced by the thermal neutron induced nuclear reaction $^{37}Cl(n,\gamma)^{38}Cl$, and thermalized by multiple collisions with $CClF_3$ which is present in large excess. The addition process favors the terminal position, but the terminal/central ratio is dependent upon the scavenger HI concentration, i.e., upon the time required for scavenging of stabilized $C_3H_6{}^{38}Cl$ radicals. The terminal/central ratio varied between 6.5 to 12.3 in these experiments, and was consistently related only to HI concentration. The increasing $CH_3CHCH_2{}^{38}Cl$ concentration with lower HI concentration indicates the isomerization of $CH_2CH^{38}ClCH_2$ to $CH_3CHCH_2{}^{38}Cl$ with a rate constant of approximately $10^7\ s^{-1}$. The original terminal/central addition ratio for thermal atomic Cl is about 6.

1223 Thermal ^{38}Cl atom sources. Neutron irradiation of $CClF_3$ and CCl_2F_2. Lee, F.S.C.; Rowland, F.S. (Univ. of California, Irvine). **81**: No. 13, 1229-1235(30 Jun 1977).

The energetic chemical reactions of ^{38}Cl formed by the $^{37}Cl(n,\gamma)^{38}Cl$ nuclear reaction account for only 3 and 6 percent of the total yield in $CClF_3$ and CCl_2F_2, respectively. The remainder are thermalized by multiple nonreactive collisions with the source molecules, and can then react thermally with chosen substrate molecules. At substrate mole fractions less than 0.1 energetic ^{38}Cl reactions with the substrate represent a negligible fraction of the total ^{38}Cl. Radiation effects can be quite important in perturbing radioactive product distributions but can be kept well within tolerable experimental limits.

1224 Thermal ^{38}Cl atom reactions with ethylene. Lee, F.S.C.; Rowland, F.S. (Univ. of California, Irvine). **81**: No. 13, 1235-1239(30 Jun 1977).

The reactions of thermal chlorine atoms with ethylene have been studied using radioactive ^{38}Cl atoms from the neutron reaction $^{37}Cl(n,\gamma)^{38}Cl$ on $CClF_3$. The ^{38}Cl atoms are moderated to thermal energies by multiple collisions with $CClF_3$(mole fraction greater than 0.9), and then allowed to react with C_2H_4 plus HI or H_2S. The only observed product is $C_2H_5{}^{38}Cl$, representing addition to ethylene to form $C_2H_4{}^{38}Cl^*$. The decomposition rate of $C_2H_4{}^{36}Cl^*$ by loss of ^{38}Cl was measured by varying the total pressure in the system. The rates of decomposition and collisional stabilization are equal at a $CClF_3$ pressure of 800 +- 120 Torr. The rate constants for reactions 1, 10, and 15 are in the ratios $(k_{10}/k_1) = 0.60$ +- 0.05 and $(k_{15}/k_1) = 0.45$ +- 0.05 at 293 K: $^{38}Cl + C_2H_4 \rightarrow C_2H_4{}^{38}Cl^*(1)$; $^{38}Cl + HI \rightarrow H^{38}Cl + I(10)$; $^{38}Cl + H_2S \rightarrow H^{38}Cl + SH(15)$.

PROPERTIES OF RADIOACTIVE MATERIALS

REFER ALSO TO CITATION(S) 262, 301, 1606

1225 (DP-MS—77-21) Moessbauer spectra of Np(V)—Cr(III) and Np(V)—Rh(III) complexes. Karraker, D.G.; Stone, J.A. 1977. Contract EY-76-C-09-0001. 10p. (CONF-770814—2). Dep. NTIS, PC A02/MF A01.

From American Chemical Society meeting; Chicago, Illinois, United States of America (USA) (29 Aug 1977).

The Moessbauer spectra of complexes between Np(V) and Cr(III) or Rh(III) ions absorbed on cation exchange resin were measured at 4.2°K with a constant acceleration Moessbauer spectrometer. The spectrum of the Np(V)-Cr(III) complex showed a strong magnetic splitting with Moessbauer parameters of $g_o\mu$/sub N/H/sub eff/ 9.91 cm/sec, 1/4 eqQ = -2.9 cm/sec, and delta = 1.69 cm/sec. The spectrum of the Np(V)-Rh(III) complex was dominated by quadrupole splitting with a minor fraction showing magnetic hyperfine structure. The results of these measurements are consistent with the suggested structure of the complexes—substituting NpO_2^+ in the transition metal ion coordination sphere—and the magnetic properties of paramagnetic Cr(III) ion ($3d^3$, high spin) and diamagnetic Rh(III) ion ($4d^6$, spin = 0).

1226 Entropy correlation for the 4f and 5f metals: relation of electronic properties to metallic radii, magnetic transformations and thermodynamics of vaporization. Ward, J.W.; Hill, H.H. (Los Alamos Scientific Lab., N.Mex. (USA)). pp 65-79 of In Heavy element particles. Mueller, W.; Blank, H. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides and 4. international transplutonium element symposium; Baden-Baden, Germany, F.R. (13 Sep 1975).

A systematic treatment of the thermodynamic properties of the actinides has proven to be a difficult, or even impossible task. The diversity of just the metals from actinium through americium is well-known; as more and more transplutonium metals have become available for measurement, there is the hope that perhaps here a simpler picture, more akin to the lanthanides, may emerge. The condensed-phase entropy for the lanthanide and many actinide metals is a predictable quantity which can be accurately calculated on the basis of metallic radius, molecular weight and magnetic configuration. Implicit in the correlation is a knowledge of the electronic structure, which also implies a relatively well-defined metallic valence. Thus, for the early actinides Pa, U, Np and Pu, in which f-electrons are involved in the metallic bond, accurate entropy values are not predictable, though their nonmagnetic state is shown. It is believed that the immense diversity of the actinide series, at least from Ac through Pu, precludes the success of any one theoretical model for the thermodynamic properties of these metals. The entropy is shown to be a property through which the diverse natures of these elements can be better understood.

COMBUSTION CHEMISTRY

REFER ALSO TO CITATION(S) 188, 381, 383, 387, 1220

1227 (SAND—77-8502) **Split-operator, finite difference solution for axisymmetric laminar jet diffusion flames.** Kee, R.J.; Miller, J.A. Apr 1977. Contract EY-76-C-04-0789. 22p. (CONF-770620—1). Dep. NTIS, PC A02/MF A01.

From Computational fluid dynamics conference; Albuquerque, New Mexico, United States of America (USA) (3 Jun 1977).

A split-operator numerical method is developed to solve the steady, laminar, diffusion flame problem. Splitting the chemical kinetic terms from the fluid mechanical terms ameliorates some of the difficulties associated with the disparate time scales and stiffness in the set of equations which describe highly exothermic diffusion flames. Implicit differencing methods enhance the numerical stability of both operators. Special care is taken to maintain the accuracy of the solution, and the coordinate system is continuously varied to follow the flame shape. The present method allows a detailed study of the complex interaction between the fluid mechanics and the finite-rate chemical kinetics in a flame.

1228 **Mechanism of smoldering of cellulosic materials.** Moussa, N.A.; Toong, T.Y.; Garris, C.A. (Massachusetts Inst. of Tech., Cambridge). pp 1447-1457 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

A coordinated theoretical and experimental investigation of the mechanism of smoldering in cellulosic materials has been conducted. Both steady and transient smoldering have been observed for single cylindrical cellulosic elements, mounted horizontally in quiescent oxygen/nitrogen environments of varying pressures and compositions. An extinguishment limit, separating the steady from transient regions, is observed at well-defined combinations of oxygen mole fraction and partial pressure. In the region of steady smoldering, the measured propagation speed and maximum temperature in the smoldering zone depend on the oxygen partial pressure and mole fraction in the environment. However, independent of the environmental conditions, the speed is uniquely related to the maximum temperature. It is postulated that cellulose, upon heating, decomposes to yield char and volatiles. The char then reacts with oxygen, diffusing from the surroundings, to provide the heat flux needed to sustain pyrolysis. On the basis of this mechanism, the predicted characteristics of steady smoldering and of the extinguishment limit are found to be in good agreement with the experimental results, thus demonstrating the validity of the proposed mechanism.

1229 **Charring pyrolysis of wood in fires by laser simulation.** Lee, C.K.; Chaiken, R.F.; Singer, J.M. (Bureau of Mines, Pittsburgh). pp 1459-1470 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

Utilizing a 250 watt CO_2-laser radiation source, wood pyrolysis at fire-level surface heat flux was investigated through the measurement of decomposition rates, solid temperatures and thermal properties, pyrolysis gas compositions and pressures, and crack formation. Heats of reaction calculated from these measurements show that at an incident heat flux of 0.76 cal/cm^2-sec applied parallel to the wood grain direction, the pyrolysis layer (approximately 1 cm thick) can be divided into three zones: (1) an endothermic primary decomposition zone at temperatures T less than 250°C, (2) an exothermic partial char zone at 250°C less than T less than 340°C, and (3) an endothermic surface char zone at 340°C less than T less than 520°C. The overall mass weighted effective heat of reaction is endothermic to the extent of -146 cal/g. At 2.0 cal/cm^2-sec applied parallel or perpendicular to grain direction, pyrolysis reaction proceeds as a charring wave of approximately 0.5 cm thickness advancing into the wood. The charring wave (250°C less than T less than 450°C) is characterized by active overall exothermic reactions accompanied by rapid solid density change. In front of the wave is an endothermic primary decomposition zone, and behind the wave is an exothermic char layer (T less than 800°C) of relatively constant density. The overall heat of reaction at the higher heat flux is exothermic, being greater for perpendicular heating (260 to 410 cal/g) than for parallel heating (25 to 94 cal/g). For parallel heating at both heat fluxes, macroscopic cracks (approximately 1 mm wide) occur in the pyrolysis region, whereas for perpendicular heating no cracks are observed. Present results show that the wood pyrolysis process is dependent upon the external heating rate, the total time of heating, and the anisotropic properties of wood and char relative to the internal flow of heat and gas.

1230 **Cellulose pyrolysis kinetics and char formation mechanism.** Lewellen, P.C.; Peters, W.A.; Howard, J.B. (Massachusetts Inst. of Tech., Cambridge). pp 1471-1480 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

The pyrolysis of cellulose was studied by electrically heating in helium single strips of low ash predried filter paper supported inside a folded wire mesh heating element mounted in a sealed vessel. The samples were rapidly brought to a desired temperature, held there for a desired time and then rapidly cooled. Extents of conversion to volatiles, measured by weighing samples before and after experiments of known duration, were determined as a function of residence time, final temperature, heating rate, and ambient pressure. Pyrolysis kinetics was determined by nonisothermal techniques to account for substantial reaction occurring during sample heat-up and cool-down. All of the cellulose was converted to volatiles without char formation, except when an extended heating period at a low temperature preceded the pyrolysis at higher temperatures. The kinetics data are well described by a single-reaction first-order decomposition model with an activation energy of 33.4 kcal/mole and a frequency factor of $6.79 \times 10^9\ s^{-1}$. The results indicate that the residence time of volatile products within the pyrolyzing cellulose matrix is extremely important in determining conversion. Suggested pathways for cellulose pyrolysis that are consistent with these findings and with much of the pertinent literature involve primary decomposition to an oxygen-rich intermediate (probably levoglucosan) which then participates in three processes to extents depending on experimental conditions: (a) direct escape from the decomposing material into the ambient gas; (b) polymerization, cross-linking and cracking to form char and (c) pyrolysis to smaller volatiles. Accordingly, char is not a primary product, and the yield of char is zero for extremely short residence times of the primary products within the matrix of the decomposing material or for conditions that permit complete inhibition of char formation by secondary pyrolysis products.

1231 **Simple calculation scheme for the luminous-flame emissivity.** Yuen, W.W.; Tien, C.L. (Univ. of California, Berkeley). pp 1481-1487 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

A simple expression for the total emissivity of a luminous flame has been established on the basis of a flame-radiation model that consists of gray soot and non-gray gases. The gray-soot approximation is demonstrated to be an accurate characterization of soot emission from both the analytical formulation and the experimental observations. This simple model also allows a comparative analysis of soot emission characteristics in flames produced by various common solid and gaseous fuels. The present calculations for the luminous-flame emissivity show excellent agreement with existing experimental data and exact analysis.

1232 **Numerical method for two dimensional unsteady reacting flows.** Butler, T.D.; O'Rourke, P.J. (Los Alamos Scientific Lab., NM). pp 1503-1515 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

In this paper we present a method that numerically solves the full two-dimensional, time-dependent Navier-Stokes equations with species transport, mixing, and chemical reaction between species. The generality of the formulation permits the solution of flows in which deflagrations, detonations, or transitions from deflagration to detonation are found. The solution procedure is embodied in the RICE computer program. RICE is an Eulerian finite difference computer code that uses the Implicit Continuous-fluid Eulerian (ICE) technique to solve the governing equations. We first present the differential equations of motion and the solution procedure of the RICE program. Next, a method is described for artificially thickening the combustion zone to dimensions resolvable by the computational mesh. This is done in such a way that the physical flame speed and jump conditions across the flame front are preserved. Finally, the results of two example calculations are presented. In the first, the artifical thickening technique is used to solve a one-dimensional laminar flame problem. In the second, the results of a full two-dimensional calculation of unsteady combustion in two connected chambers are detailed.

1233 Prediction of a horizontal free turbulent diffusion flame. Gosman, A.D.; Lockwood, F.C.; Syed, S.A. (Imperial Coll. of Science and Tech., London). pp 1543-1555 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

Predictions have been obtained for a horizontal, free-jet, gaseous-fueled, turbulent diffusion flame and compared with data. The predictions are generated by solving a differential equation set comprising the usual conservation equations for mass, momentum, energy, and a mixing parameter, augmented by further equations which describe the effect of turbulence on transport and mixing, the latter being based on a statistical approach. Solution is by a three-dimensional marching integration procedure, using a grid which grows with the flame. The agreement obtained with experiment is moderately good, but less satisfactory than for similar studies of the vertical axisymmetric flame.

1234 Gravitational effects on chemically reacting laminar boundary layer flows over a horizontal flat plate. Lavid, M. (Princeton Univ., NJ); Berlad, A.L. pp 1557-1568 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

This is a theoretical study of the chemically reacting laminar boundary layer flow over a horizontal flat plate with gravitationally induced buoyant force. A diffusion flame sheet model was invoked to describe the combustion process. The effects of gravity on the purely force convection flow are characterized by a dimensionless coordinate quantity Gr/sub x//Re/sub x//sup $^{3}/_{2}$/. The problem inherently is a coordinate perturbation and it is treated as such. A numerical solution of the zeroth and first order governing equations subject to the appropriate physical boundary conditions was obtained for various external flow conditions such as wall temperature, freestream oxygen concentration and aiding and opposing flows. It was shown that the cross stream buoyancy induced body force acts effectively to produce a streamwise pressure gradient in the fluid adjacent to the plate surface. The pressure gradient is favorable in aiding flows (plate facing upwards) and is adverse in opposing flows (plate facing downwards). Hence, the local boundary layer flow is accelerated or decelerated relative to the corresponding gravity-free forced convection flow. Correspondingly, there is an increase or decrease in the local skin friction and heat transfer rates, and consequently a decrease or increase in the flame "stand-off" distance, depending upon whether aiding or opposing flow occurs, respectively. It was concluded that buoyancy plays an important role in boundary layer diffusion flames. Such previously unaccounted for effects include the acceleration of the boundary layer flow (sometimes a velocity overshoot is exhibited), and a decrease in the flame "stand-off" distance.

1235 Maintained detonation waves in an annular channel: a hypothesis which provides the link between classical acoustic combustion instability and detonation waves. Edwards, B.D. (Rolls-Royce Ltd., Derby, Eng.). pp 1600-1618 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

This paper is an account of a part of a research program carried out at Rolls-Royce Limited. The program was directed at evaluating the benefits which may accrue by using detonation waves as the heat addition process in an airbreathing gas turbine power plant. The concept of a maintained detonation wave moving around an annulus which is continuously replenished with fresh combustibles is well known. The work is largely experimental and is directed at the attainment of a demonstration of such a maintained moving detonation wave in ethylene/oxygen/air mixtures. The detonation wave moves into fresh combustibles which are introduced through continuous inlet slits in the annular chamber wall at right angles to the direction of the propagation of the wave. The design has no moving mechanical parts, and the valving of the gas flow is achieved gas-dynamically by matching the pressure profiles behind the detonation wave to the pressure of the inflowing combustibles. The two or three supersonic combustion waves which propagate in a stable fashion have pressure ratios between 2 and 10 and velocities between 1100 and 1500 m/s. These results are functions of the energy content of the incoming combustibles and the gas dynamics of the scavenging and refilling processes. Consideration of all these results has led to the conclusion that all such waves propagating with constant velocity around a continuously replenished annular channel obey the Chapman-Jouguet hypothesis for stable detonations; the unusually low pressure ratios and velocities are accounted for by consideration of the conditions of the gas upstream of the wave which results from incomplete scavenging with fresh combustibles of the hot combustion products of the pressure wave. This explanation provides the link between maintained rotating detonation waves and classical acoustic instability.

1236 Combustion considerations for future jet fuels. Blazowski, W.S. (Air Force Aero Propulsion Lab., Wright-Patterson AFB, OH). pp 1631-1639 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

This paper presents recent results which contribute to the combustion technology base necessary for the future development of aircraft jet fuels from non-petroleum resources. Specifically, the effects of fuel hydrogen and nitrogen content have been studied using a T56 combustor rig. Although most of this work has involved fuel blending to simulate alternate fuel properties, data acquired using an actual oil shale jet fuel have been included. Increases of combustor linear temperature with decreased fuel hydrogen content were found to be substantial. A new, non-dimensional temperature parameter is presented which provides an excellent means of correlating results for combustors having rich primary zones designs. Limited data for new, low-smoke lean designs indicate much less sensitivity of combustor liner temperature to fuel hydrogen content. Although smoke emission also increased with decreased hydrogen content, gaseous exhaust emissions were unchanged. Fuel bound nitrogen conversion to NO/sub x/ under practical aircraft combustion conditions (up to 838°K inlet temperature) was found to be dependent on both fuel nitrogen concentration and combustor inlet temperature. Finally, future directions for alternate jet fuel combustion efforts are summarized. Recommendations range from an expanded scope of combustor and engine testing to required fundamental combustion research.

1237 Prediction of turbulent diffusion flame fields and nitric oxide formation. Kent, J.H.; Bilger, R.W. (Univ. of Sydney). pp 1643-1656 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

Several contributions are made to the numerical modelling of turbulent diffusion flames. The use of Favre averaging to account for the strong density differences is developed and together with the Favre form of the k epsilon 1 turbulence model is used to predict the flow and composition fields in hydrogen/air diffusion flames. The form of the probability density functions is found to have little effect on the velocity and conserved scalar mean fields but is more significant in determining mean temperatures and molecular species compositions. Nitric oxide formation is computed by means of the theory which relates non-equilibrium O-atom concentrations to the fine scale fluctuations in the turbulence. The results show much improvement over the equilibrium O-atom theory. Nitric oxide concentrations are particularly sensitive to the form of the probability density function.

1238 Development of the eddy-break-up model of turbulent combustion. Spalding, D.B. (Imperial Coll. of Science and Tech., London). pp 1657-1663 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

A new expression is presented for the time-average reaction rate in a turbulent flame, whether of uniform or non-uniform fuel-air ratio. It is based on the idea of coherent gas "parcels," which are subjected to a stretching process while reaction and small-scale mixing take place. The expression has been used for the prediction of flame spread behind a baffle, and for the turbulent diffusion flame. An outline is given of a more complete theory, still under development.

1239 Dissipation fluctuations and the structure and propagation of turbulent flames in premixed gases at high Reynolds numbers. Chomiak, J. (Massachusetts Inst. of Tech., Cambridge). pp 1665-1673 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

At high Reynolds numbers turbulent fine structure is not uniformly distributed but concentrated in small isolated regions, whose entire volume is a small fraction of the total volume of a flow field. The concentrated fine structure can be modeled by a permanent, random distribution of vortex tubes of the Kolmogorov microscale. A simplified model of this concentrated vortex structure-flame interaction showing a strong coupling of these phenomena through a vortex bursting mechanism has been developed and used for prediction of flame propagation velocity, flame dispersion and structure. Good agreement between experimental data and those predicted by this model over a range of turbulence parameters, gas temperatures, pressures and mixture composition has been obtained giving an explanation of some poorly understood features of the turbulent flames.

1240 Eddy viscosity modeling in the prediction of turbulent, backmixed combustion performance. Peck, R.E.; Samuelsen, G.S. (Univ. of California, Irvine). pp 1675-1687 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

The turbulent flowfield in a backmixed combustor is modeled analytically by simultaneously solving the governing partial differential conservation equations. An algebraic and a two-equation eddy viscosity model are employed in the numerical simulation to account for the turbulence transport processes. Predicted distributions of isothermal flow properties are systematically compared to experimentally obtained data to appraise the eddy viscosity models. In addition, predicted distributions of reacting flow properties are presented to illustrate the applicability of current numerical methods to the prediction of continuous combustion flows. The turbulent momentum and mass transport properties are evaluated in isothermal flow for a range of mixing conditions. Both eddy viscosity models qualitatively describe the system hydrodynamics, but the detailed flow structure is inadequately represented. The mass transport predictions from the algebraic viscosity model agree favorably with experiment. The inferior performance of the two-equation viscosity model is remedied by refining the boundary condition specification for the turbulence energy dissipation rate. It is shown that the turbulence energy dissipation rate adjacent to critical solid walls strongly influences the overall mixing characteristics of the two-equation model. The isothermal flow results indicate that the algebraic eddy viscosity model provides cost-effective predictions of the general fluid flow patterns and mass transport trends in confined flows exhibiting strong recirculation. The two-equation eddy viscosity model provides better resolution of the small-scale turbulence processes but requires careful testing to ensure realistic predictions. The hot flow calculations accentuate the inadequate transport characteristics identified in the isothermal flow analysis and verify that considerable testing of the numerical model is required before proceeding to the complicating conditions of combustion.

1241 Prediction of buoyancy controlled turbulent wall diffusion flames. Kennedy, L.A.; Plumb, O.A. (Univ. of New York, Buffalo). pp 1699-1707 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

A numerical model of a buoyancy dominated turbulent diffusion flame adjacent to an inert vertical surface is developed. The K-epsilon-g model of turbulence was modified to account for the generation of turbulent kinetic energy and dissipation due to buoyancy and describes the fluctuations of a conserved scalar quantity. The combustion model assumes infinitely fast reactions and the local burning rate is obtained by solving for the source term in the fuel species equation. Due to the lack of experimental flame data, results are comared to non-reacting flow experimental data with good agreement. Sample results for a propane-air flame are presented.

1242 Nozzle fluid concentration fluctuation field in round turbulent free jets and jet diffusion flames. Ebrahimi, I. (Arya-Mehr Univ. of Tech., Teheran); Kleine, R. pp 1711-1723 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

Mathematical modeling of turbulent diffusion flames requires a knowledge of the distribution of concentration fluctuations in the flame field. The effect of these fluctuations is to broaden the reaction region and extend the flame length beyond the value computed from the mean concentrations. Since it is a simple means of measuring the nozzle fluid concentration and its fluctuations, the light scattering technique formerly applied to isothermal air jets has been developed for use in flames. Measurements are reported for isothermal air jets and stabilized as well as lifted flames.

1243 Slowdown of oxyhydrogen detonation by surface catalysis. Fujiwara, T. (Ames Research Center, Moffett Field, CA). pp 1771-1780 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

The propagation velocities of stoichiometric oxyhydrogen detonations were measured in thin tubes of different wall materials. From 4 to 6 percent velocity differences were observed consistently for pyrex and γ-alumina walls. By changing the tube geometries, it was confirmed that this velocity difference can be explained only by the catalysis of the wall material. To elucidate this result, one-dimensional gasdynamic analysis was performed, including various possible wall reactions. The solutions of this eigenvalue problem gave the relation of each reaction and its catalytic efficiency to the calculated detonation velocity. The results showed that the observed velocity difference can be explained only if we assume that $H + OH \rightarrow H_2O$ or $H \rightarrow \frac{1}{2} H_2$ occurs with the maximum catalytic efficiency, i.e., unity. After some speculations, $H + OH \rightarrow H_2O$ was considered more probable, the catalytic efficiency of γ-alumina being nearly unity for this reaction at 300°K.

1244 Gas phase decomposition of nitric oxide in combustion products. Muzio, L.J. (KVB, Inc., Tustin, CA); Arand, J.K.; Teixeira, D.P. pp 199-208 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

The gas-phase decomposition of NO in combustion products by H_2, CH_4, C_2H_6, CO, NH_3, and amines was studied over temperatures ranging from 700°K to 1930°K and over a wide range of excess oxygen levels, initial NO levels, and ratios of secondary fuel to initial NO. The NO-reduction tests were conducted in a 58.6 kJ/sec (200,000 Btu/hr) plug flow combustion tunnel fired with natural gas. The NO-reducing agents were mixed with the primary combustion products downstream of the main combustion zone by injection through a series of high velocity jets. Residence times in the test section were on the order of 500 msec. A water-cooled probe was used to withdraw samples at various axial and radial locations in the test section. The gas samples were then analyzed for NO, O_2, CO, NH_3, and HCN. Ammonia and other amines were shown to preferentially react with the NO in the primary combustion products in the presence of excess oxygen. These reactions were found to occur at temperatures ranging between 980°K and 1370°K. With NH_3 injection, 78% reductions in NO were achieved at an optimum temperature of 1240°K and molar ratio of injected ammonia to initial NO of approximately 1:1. In contrast, only small reductions in NO were achieved with CO or H_2, at molar ratios of CO (or H_2) to initial NO up to 14 over the temperature range of 980°K to 1850°K, also with a lean primary mixture. For the particular test conditions, a ratio of CO (or H_2) to initial NO of 80 was necessary to make the overall mixture stoichiometric. The data showed that the CO, H_2, methane and ethane reacted preferentially with the excess oxygen in the combustion products. With CH_4 and C_2H_6, significant reductions in NO occurred only after sufficient reductant was injected to consume the excess oxygen and render the overall mixture fuel rich.

1245 Water addition to practical combustion systems: concepts and applications. Dryer, F.L. (Princeton Univ., NJ). pp 279-295 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

The use of water as an ancillary combustion control technique has recently received renewed interest. This paper historically reviews the applications of water addition to practical combustion systems and discusses in detail the fundamental aspects of combustion which are affected. Combustion properties of water-in-fuel emulsions are elaborated upon, and several potentially favorable applications which require additional research are identified.

1246 Theory of convective, transient, multicomponent droplet vaporization. Law, C.K.; Prakash, S.; Sirignano, W.A. (Princeton Univ., NJ). pp 605-617 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

The vaporization of a multicomponent droplet in a strong convective gas stream is analyzed, with particular emphasis on the generation of internal circulation through the surface shear and its effect on the internal heat and mass transport processes. It is demonstrated that boundary layers exist in both the gas and liquid phases near the droplet surface over most of its lifetime, and that convection is an important transport mode within the droplet. An approximate analysis for the shoulder region then shows that: the more volatile compounds are always preferentially vaporized; in the liquid the more/less volatile compounds diffuse outward/inward respectively; and the relative rates with which the droplet heats up and conforms to the gas motion are expected to strongly influence the droplet behavior. A more general model, consisting of an exterior potential flow, an interior Hill's Vortex, and boundary layers near the interface, is outlined to study the transient behavior of the droplet.

1247 Soot and hydrocarbon formation in a turbulent diffusion flame. Prado, G.P.; Lee, M.L.; Hites, R.A.; Hoult, D.P.; Howard, J.B. (Massachusetts Inst. of Tech., Cambridge). pp 649-661 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

Formation and emission of soot and polycyclic aromatic hydrocarbons (PCAH) from a turbulent continuous flow combustor have been studied. Measurements included mass concentration of both soot and PCAH, composition of individual PCAH, and size distribution of soot particles, as a function of mixing intensity, fuel equivalence ratio and type of fuel (kerosene and benzene). Both soot and PCAH concentrations reach maxima early in the flame, after which PCAH decays rapidly and soot decays much slower. The maximum PCAH concentration always preceded that of soot in agreement with the concept that certain PCAH may serve as intermediates in soot formation. An approximate calculation based on the assumptions of local equilibrium with respect to soot formation and a Gaussian distribution of air-fuel mixedness gave satisfactory correlations of the data on soot formation at the higher cold gas velocity. At the lower velocity, the amount of soot and PCAH formed was drastically increased and strongly dependent on fuel atomization.

1248 Collisional growth of soot particles at high temperatures. Graham, S.C. (Thornton Research Centre, Chester, Eng.). pp 663-669 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

Recently, we have shown that the light-scattering behaviour of soot aerosols in incident shock flows (duration approximately 3 ms) at approximately 1800°K is consistent with the predictions of free-molecule coagulation theory. However, agreement between theory and experiment is obtained only if it is assumed that the collisions between soot particles are coalescent in that the collision partners fuse completely after each collision to form a new spherical particle. The aim of the present study is to determine as directly as possible, whether the collisions that occur in the first 1 to 2 milliseconds following nucleation are indeed coalescent or chain forming. This was achieved from observations on soot aerosols generated in cycloheptatriene/argon shock-flows at approximately 1750°K using a laser light-scattering technique in which the polarization of the incident beam was modulated at approximately 20 kHz. The ratios of the absorbances of the aerosol at 488 nm and 3.39 μm were also measured to assess the relative proportions of true soot (I.R. absorbing) and polynuclear aromatics (I.R. transparent) in the condensed phase. The polarization modulation permitted the variation in the ratio of the differential light-scattering cross-sections of the aerosols, for light-scattered perpendicular and parallel respectively to the polarization direction of the linearly polarized incident beam, to be measured during the same shock flow. This ratio was observed to increase throughout the flow, showing that the scattering properties of the particles become more and more like those of isotropic spheres as time proceeds. This behaviour is the opposite of that predicted for chain-forming collisions. The small but significant scattering that is observed along the polarization direction of the incident beam is attributed to an intrinsic, rather than a shape anisotropy, that reflects the highly anisotropic nature of the polynuclear aromatics that are present in the particles.

1249 Estimation of the stability of droplet as nucleus of soot formation in hydrocarbon flames. Jinno, H.; Fukutani, S.; Takaya, A. (Kyoto Univ.). pp 709-718 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

The reaction path in the nucleation of soot formation in hydrocarbon flames has been studied based on the thermodynamic equilibrium. The possibility that hydrocarbons condense into liquid droplets even at temperatures above their boiling points has been investigated and the following theoretical explanations have been obtained. A system that contains charged molecules is more unstable energetically than one that contains no charged molecules. This electric energy decreases as the molecules in the vapor phase condense into droplets because the electric energy is inversely proportional to the charged particle diameter. The condensed droplet then grows spontaneously to a size which can be computed as a function of the vapor pressure, using Kelvin's equation. The physical properties required to compute the diameter were estimated approximately for hydrocarbons up to circumanthracene, $C_{40}H_{16}$. The diameter of a droplet of hydrocarbon in equilibrium with its vapor was evaluated at various vapor pressures and temperatures. Droplets charged can be freed from evaporation, increase in size as polymerization reactions proceed, and grow to soot nuclei. It is ascertained experimentally that heavy hydrocarbons are less abundant than light hydrocarbons. The paths along which nucleation proceeds were proposed with due consideration to the above points.

1250 Mathematical modeling of turbulent combustion with special emphasis on soot formation and combustion. Magnussen, B.F.; Hjertager, B.H. (Norwegian Inst. of Tech., Trondheim). pp 719-729 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

Principles of mathematical models as tools in engineering and science are discussed in relation to turbulent combustion modeling. A model is presented for the rate of combustion which takes into account the intermittent appearance of reacting species in turbulent flames. This model relates the rate of combustion to the rate of dissipation of eddies and expresses the rate of reaction by the mean concentration of a reacting specie, the turbulent kinetic energy and the rate of dissipation of this energy. The essential features of this model are that it does not call for predictions of fluctuations of reacting species and that it is applicable to premixed as well as diffusion flames. The combustion model is tested on both premixed and diffusion flames with good results. Special attention is given to soot formation and combustion in turbulent flames. Predictions are made for two C_2H_2 turbulent diffusion flames by incorporating both the above combustion model and the model for the rate of soot formation developed by Tesner et al., as well as previous observations by Magnussen concerning the behavior of soot in turbulent flames. The predicted results are in close agreement with the experimental data. All predictions in the present paper have been made by modeling turbulence by the k-epsilon model. Buoyancy is taken into consideration in the momentum equations. Effects of terms containing density fluctuations have not been included.

1251 Boundary layer combustion of carbon. Adomeit, G.; Mohiuddin, G.; Peters, N. (Rheinisch-Westfaelische Technische Hochschule, Aachen). pp 731-743 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

A theoretical investigation of the oxidation of carbon in stagnation point boundary layer flow has been performed for the case of frozen flow, equilibrium flow and the kinetically controlled flow regime. It is shown that the experimental combustion rate data of Matsui et al. could be reproduced by a frozen flow calculation, if the kinetic parameters were adequately adjusted. However, the

heterogeneous reaction rates thus obtained correspond to a predominant primary combustion to CO_2, rather than to CO in contrast to previously reported results in the literature. Also it is found that the assumption of heterogeneous equilibrium would predict higher combustion rates than those experimentally observed. Consequently, on the basis of the primary CO/CO_2 ratio given in the literature, a model was analyzed which considers predominant heterogeneous combustion to CO with subsequent homogeneous oxidation of CO to CO_2 in the nonequilibrium flow regime. These calculations reveal a very strong influence of moisture upon the homogeneous combustion rate. In dry air the conversion of CO to CO_2 is practically frozen, but at relative humidities of 10% or higher it is enhanced by a factor of about 5×10^3 compared to the dry air reaction rate. As the location of stoichiometric composition is very close to the surface, homogeneous combustion takes place under fuel lean conditions.

1252 Temperature and concentration measurements in reactive media by coherent anti-Stokes Raman scattering. Pealat, M.; Druet, S.; Attal, B.; Taran, J.P. (Office National d'Etudes et de Recherches Aerospatiales, Chatillon, France). pp 789-807 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

We present the application of Coherent anti-Stokes Raman Scattering (CARS) to the investigation of the diffusion flame on a wetted spherical burner. The theory is reviewed briefly, together with instrumental considerations. The setup is described. Temperatures and concentrations were measured from spectral contours of N_2; CO was also detected and its concentration profile was plotted.

ENGINEERING

GENERAL ENGINEERING

1253 (ERDA—77-102) **Nuclear engineering enrollments and degrees, 1976.** Jul 1977. Contract EY-76-C-05-0033. 54p. Dep. NTIS, PC A04/MF A01.

Results of the sixth annual survey of Nuclear Engineering Enrollments and Degrees are presented. Each year the survey is sent to institutions offering degrees in nuclear engineering or other engineering fields with nuclear engineering options. The number of institutions may change from year to year as new programs are identified and other programs are discontinued; however, historical information about degrees granted since 1966 is collected for all institutions. In this current survey one new respondent was added (Clarkson College of Technology), and two institutions (California Institute of Technology and Washington State University) reported discontinuation of their programs. The survey materials were changed in two ways for this report. First, a sub-breakout of race or ethnic groups by sex was added, and an additional response "still seeking employment" was included on the placement form.

FACILITIES AND EQUIPMENT

REFER ALSO TO CITATION(S) 1364

1254 (SAND—77-0869) **Development of transformation equations for remote tracking.** Finnell, R.T. Aug 1977. Contract EY-76-C-04-0789. 35p. Dep. NTIS, PC A03/MF A01.

A method to accurately parallax-correct tracking data is needed at the Tonopah Test Range which can be executed by a minicomputer in a very short time. Spherical transformation equations were developed that give very accurate results when adapted to a given region on the earth's surface. These calculations will run very fast on a 16-bit minicomputer as no floating point and very little double-precision processing is required. Results show that calculated target locations are accurate to within one foot of those calculated with a geocentric formula.

1255 (UCID—17304(Pt.1)) **Smart limbed vehicles for naval applications. Part I. Performance analysis.** Weisberg, A.; Wood, L. 30 Sep 1976. Contract W-7405-ENG-48. 207p. Dep. NTIS, PC A10/MF A01.

Research work in smart, unmanned limbed vehicles for naval warfare applications performed during the latter part of FY76 and FY76T by the Special Studies Group of the LLL Physics Department for the Office of Naval Research is reported. Smart water-traversing limbed remotely navigated vehicles are interesting because: they are the only viable small vehicle usable in high sea states; they are small and work on the ocean surface, they are much harder to detect than any other conventional craft; they have no human pilot, are capable of high-g evasion, and will continue to operate after direct hits that would have crippled a human crew; they have the prospect of providing surface platforms possessing unprecedented speed and maneuverability; unlike manned information-gathering craft, they impose almost no penalty for missions in excess of 10 hours (no need to rotate shifts of crewmen, no food/lavatory requirements, etc.) and, in their "loitering mode", waterbugs could perhaps perform their missions for days to weeks; they are cheap enough to use for one-way missions; they are mass-producible; they are inherently reliable—almost impossible to sink and, in the event of in-use failure, the vehicle will not be destroyed; they maximally exploit continuing technological asymmetries between the U.S. and its potential opponents; and they are economically highly cost-effective for a wide spectrum of Navy missions. (TFD)

1256 Concept of irreversibility in heat exchanger design: Counterflow heat exchangers for gas-to-gas applications. Bejan, A. (Department of Mechanical Engineering, University of California, Berkeley, Calif.). **99**: No. 3, 374-380(Aug 1977).

The thermal design of counterflow heat exchangers for gas-to-gas applications is based on the thermodynamic irreversibility rate or useful power no longer available as a result of heat exchanger frictional pressure drops and stream-to-stream temperature differences. The irreversibility (entropy production) concept establishes a direct relationship between the heat exchanger design parameters and the useful power wasted due to heat exchanger nonideality. The paper presents a heat exchanger design method for fixed or for minimum irreversibility (number of entropy generation units N/sub s/). In contrast with traditional design procedures, the amount of heat transferred between streams and the pumping power for each side become outputs of the N/sub s/ design approach. To illustrate the use of this method, the paper develops the design of regenerative heat exchangers with minimum heat transfer surface and with fixed irreversibility N/sub s/.

1257 Single-spindle aspheric figuring with flexible pads. Brown, N.J. (Lawrence Livermore Laboratory, P. O. Box 808, Livermore, California 94550). **1**: No. 1, 33-34(Jul 1977).

The pressure and relative velocity at any point under a polishing pad are shown to be identical to those under the pad center when averaged over a number of cycles. This allows the wear calculations for parameters such as stroke, load, dimensions, rpm, pad, and wear constants to be performed on a hand calculator instead of a large computer.

CRYOGENIC AND SUPERCONDUCTING EQUIPMENT AND DEVICES

REFER ALSO TO CITATION(S) 585, 589, 590, 1969, 1978, 1979, 1980, 1981, 1982

1258 (AD-A—039661) **Systematic survey of naval surveillance and communication systems. Final report 30 Sep 1976—31 Mar 1977 on phase 1.** Schwartz, P.; Roth, L. Mar 1977. Contract N00173-76-C-0389. 78p. NTIS PC A05/MF A01.

This report contains a survey of the properties of Josephson-effect devices and an evaluation of their potential utility in Naval surveillance and communication systems. Emphasis was placed on finding an existing system that could be retrofitted to improve performance. The study focused on receiver front-end characteristics and signal-processing applications. Recommendations were made for the development of a superconductive front-end for millimeter-wave applications or the development of an integrated high-speed signal-processing capability.

PROTECTIVE STRUCTURES AND EQUIPMENT

REFER ALSO TO CITATION(S) 1313

1259 (NTIS/PS—77/0482) **Electromagnetic shielding. Volume 2. 1972—May 1977 (a bibliography with abstracts). Report for 1972—May 1977.** Reed, W.E. Jun 1977. 207p. NTIS PC N01/MF N01.

The bibliography presents research on electromagnetic shielding of electronic and electrical equipment, personnel, and ordnance. The shielding effectiveness of materials and structures is covered. Nuclear electromagnetic pulse shielding is included. (This updated bibliography contains 202 abstracts, 95 of which are new entries to the previous edition.) See also NTIS/PS-75/366, Electromagnetic Shielding. Vol. 1. 1964-1971.

1260 (NP-tr—1984) **Explosion-resistant construction designs.** Uemura, S. Translated from **26**: No. 6, 318-325(1965). 14p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The design of explosive-resistant structures is reviewed. The effect of blast waves on structures is treated both experimentally and theoretically. (TFD)

HANDLING EQUIPMENT AND PROCEDURES

REFER ALSO TO CITATION(S) 272, 879

1261 **Criticality safe tank design analysis.** Summers, A.D.; Wilson, R.E. (Allied Chemical Corp., Idaho Falls, ID). **26**: 245(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

SHIPPING CONTAINERS

1262 (SAND—77-0723) **Fire protection device for LMFBR spent fuel shipping casks.** Moss, M.; Heckman, R.C. Aug 1977. Contract EY-76-C-04-0789. 21p. Dep. NTIS, PC A02/MF A01.

This report describes the analysis and experimental evaluation of a device to provide fire protection for a shipping cask used to transport liquid metal fast breeder reactor (LMFBR) fuel rods. Thermal analyses of various fire protection schemes were conducted by means of the finite difference code, CINDA. The choice of materials for the cask body was determined to be less important than the dimensions and number of cooling fins attached to the cask. Of several protection methods considered, radiation/convection shields between the cooling fins looked most attractive; these were tested on a quarter-scale cask model. The shields consisted of bimetallic bands which expanded when heated, blocking the fire, and retracted when cooled. This automatic reversibility would allow the fins to dissipate internally generated heat of a full-size cask once the fire was out. Tests showed that, even in an asymmetric fire exposure, the bands expanded to provide protection to the cask. The directly exposed surface of the cask model, protected this way, reached a temperature of only 180°C compared with 295°C in the unprotected state, when subjected to a butane flame for 0.5 h at a distance of 15 cm. Greater relative effectiveness could be expected in an engulfing fire in which the bands would expand more symmetrically.

1263 **Effective neutron isolation thickness values obtained from reflector savings data.** Howes, B.W.; Bierman, S.R.; Clayton, E.D. (Battelle Pacific Northwest Lab., Richland, WA). **26**: 243-244(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

1264 **Subcriticality design considerations for LMFBR spent fuel shipping casks.** Philbin, J.S.; Dupree, S.A. (Sandia Labs., Albuquerque, NM). **26**: 244-245(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

1265 **Nuclear regulatory commission structural technology programs for shipping containers.** Lahs, W.R. (Nuclear Regulatory Commission, Washington, DC); Von Riesemann, W.A.; Langland, R.T. **26**: 246-247(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

1266 **Design of containers for shipping unirradiated LMFBR assemblies.** Langhaar, J.W. (E. I. duPont de Nemours and Co., Aiken, SC). **26**: 247(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

MINING AND DRILLING EQUIPMENT AND FACILITIES

1267 (CONF-770836—P2, pp H.2.1-H.2.7) **Drilling rate changes when air drilling is switched to mist drilling.** Williams, C.R. (Bartlesville Energy Research Center, OK). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

Eight shallow (30-ft-deep) holes were drilled in four formations to determine if a significant portion of the reduction in penetration rate that usually occurs when air drilling is changed to mist drilling (air driller's rule-of-thumb estimates average about one-third loss) might be due to the physical action of drilling a wet, soapy rock. The results showed an average loss of 9.3 percent in the four formations drilled, with the greatest loss occurring in limestone. The softest formation (claystone) showed only a 1.2 percent reduction in penetration rate; the two sandstones averaged 10.0 percent loss; and the limestone showed a significant 15.8 percent loss. This indicates that the loss of penetration rate due to wetting the rock while mist drilling is small but would be significant when drilling a long interval. The findings indicate that when drilling hard rocks at the surface with mist instead of air, a penetration rate loss of approximately 12 percent (compared to the drilling rate with air) will occur due to the effect of jetting the soapy water through the bit onto the formation being drilled. A further investigation is required to determine if the same effect occurs while drilling at depth under varying hydrostatic heads and to determine if the effect can be eliminated to provide increased drilling rates.

1268 (CONF-770836—P2, pp H.3.1-H.3.10) **Full-scale laboratory drilling under simulated downhole conditions.** Black, A.D.; Sandstrom, J.L.; Green, S.J. (Terra Tek, Inc., Salt Lake City). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

Full-scale drilling experiments have been performed using a 7-⅞-in. rotary insert bit simulating downhole deep-well conditions. Tests were conducted using bit weights to 40,000 lb, rotary speed to 100 RPM, mud flows to 220 GPM, mud pressure to 5,000 psi, and confining pressure on the rock to about 9,000 psi. Several rock types have been drilled; data presented here include tests on Colton Sandstone and Bonne Terre Dolomite. Penetration rates from about 3 to 90 ft/hr were obtained. Penetration rates were strongly dependent on bit weight, rotary speed, and borehole mud pressure. There was only a small dependence on mud flow rates. Visual examination of the drilling patterns at simulated downhole conditions suggested ductile behavior for the sandstone, but more chipping and cratering suggested more brittle behavior for the sandstone, but more chipping and cratering suggested more brittle behavior for the Dolomite.

1269 (CONF-770836—P2, pp H.5.1-H.5.7) **Effect of drill-bit cutter offset on deep drilling.** Dropek, R.K.; Jones, A.H.; Green, S.J. (Terra Tek, Inc., Salt Lake City). 1977.

From Symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, USA (30 Aug 1977).

In Third ERDA symposium on enhanced oil and gas recovery and improved drilling methods.

Tests were performed using a single roller cone from a standard drill bit to evaluate the effects of cutter offset angle on drill-bit cutting efficiency in deep wells. For the tests, the in situ conditions of a 20,000 foot well were approximately simulated in the laboratory apparatus. A single revolution of the cone-arm configuration was made. A tight sandstone, the same as that used in the ERDA/OGST deep-drilling program (Colton sandstone, 11 percent porosity, 50 μd permeability), was used for five different offsets. Torque, thrust, and volume removed were recorded; preliminary implications that can be obtained for drill-bit design for deep-well drilling will be discussed.

LASERS

REFER ALSO TO CITATION(S) 1321

1270 (AD-A—039812) **High specific energy pulsed electric discharge laser research. Final technical report.** Douglas-Hamilton, D.H.; Feinberg, R.M.; Lowder, R.S.; Roos, J.P.; Zappa, O.L. Dec 1975. Contract DAAH01-75-C-0503. 132p. NTIS PC A07/MF A01.

Theoretical and experimental investigations are presented of laser kinetics related to the use of combustion product gases in CO2 laser systems. Several processes for producing the laser gas are also considered. The sensitivity of laser performance to gas composition and to level of impurities is considered theoretically. The role of CO and the appropriate fractions of H2 and H2O are examined. Maximum allowable amounts of impurities (O2, hydrocarbons, water vapor and particulates) are determined. The laser output was measured for a variety of gases related to possible combustion product gas mixtures. Some actual combustion product mixtures were tested as well. The measured laser performance generally agreed well with prediction, with the exception of CO-containing gases where a 15 - 25 percent discrepancy for 12 percent CO was found. No unexpected problems due to impurities were found when using the actual combustion product gas. The generation method and gas properties of the combustion product gas generated at Avco-Lycoming are presented. Various gas turbine cycles for generating the laser gas were studied. Three gas production systems are considered, open- and closed-cycle operation using stored gas (the gas being generated prior to a laser run) and open-cycle operation using on-line gas generation (the laser gas being generated during the laser run). The gas storage, open-cycle system has the disadvantage of a limited duty cycle (here taken to be 50:1), but is otherwise found to be far superior in terms of weight and volume, as well as cost. (Author)

1271 (AD-A—039833) **ARPA/NRL x-ray laser program. Final technical report.** Apr 1977. 287p. (NRL-MR—3482). NTIS PC A13/MF A01.

The ARPA/NRL x-ray laser program is concerned with demonstrating gain in the soft x-ray region. The overall program is

jointly supported by ARPA and NRL. The approaches include electron-collisional pumping of ions, resonant charge transfer pumping, optical parametric mixing to short wavelengths, traveling wave e-beam and discharge pumping, and analysis and numerical modeling. This report covers the overall program for the ARPA portion as well as the progress made during the second half of FY-76 and FY-76T for both the ARPA portion and the continuing NRL effort.

1272 (AD-A—039992) **Injection laser for high data rate communications. Final report 1 Mar 1976—28 Feb 1977.** Wittke, J.P.; Ladany, I.; Kressel, H. Apr 1977. Contract N00014-76-C-0709. 49p. (PRRL—77-CR-13). NTIS PC A03/MF A01.

Injection lasers of AlGaAs (Lambda(L) approximately 800 nm) have been permanently bonded to single-mode fibers, with power levels up to 600 microwatts being coupled into the fibers. Values over 150 microwatts were consistently obtained under cw operation at room temperature. Very close mechanical alignment tolerances are required to achieve good coupling, with positioning to + or - 1 micrometer being required. This necessitates the use of bonding materials for attaching the fiber to the laser mount that have a high dimensional stability over long time periods, and lasers whose modal patterns do not change with time or operating conditions. An epoxy provided the best bonding material that we found, although there are indications that suitable low-melting solders can also be used. Laser mode changes with drive current level can alter the observed coupling efficiency significantly.

1273 (AD-A—040006) **Kinetics, energetics and infrared lasing in high energy rocket propellant ingredients at cryogenic temperatures. Final scientific report.** McGee, H.A. Jr. Mar 1977. 76p. NTIS PC A05/MF A01.

Electric discharge and pyrolytic activation combined with cryogenic quenching have been utilized to synthesize isolable quantities of unusual small compounds of the first row elements. Most are endothermic and stable only at low temperatures. Several of these species have been burned in laser cavities of several designs to explore their efficacy in producing population inversions. Results have been generally disappointing, for no new lasers have been discovered, but work is continuing. (Author)

1274 (AD-A—041204) **Long range chain laser studies, phase I studies. Final report.** Boedeker, L.R.; Bonzyk, P.A.; Hinchen, J.J.; Tripodi, R.; Ultee, C.J. Jun 1977. Contract F29601-75-C-0139. 317p. (UTRC/R—77-952198-58). NTIS PC A14/MF A01.

The chemical and vibrational kinetics of the H_2-F_2 chain reaction were studied to improve the description of the evolution of the various vibrational levels in order to better predict chain-reaction-laser performance. Two types of experiments were performed: (1) flow tube, and (2) pulsed reaction. In the flow tube experiments, fluorine atoms were produced by passing F_2 through a mass heater. The F_2 and F emanating from the heater were mixed with additional F_2, Ar, and H_2 to achieve the desired stoichiometry.

1275 (AD-A—041520) **Investigation of plasma processes in electronic transition lasers. Annual report 1 Jun 76—1 Jul 77.** Nighan, W.L.; Hall, R.J. 1 Jul 1977. Contract N00014-76-C-0847. 68p. (UTRC/R—77-922617-2). NTIS PC A04/MF A01.

Plasma processes in electrically excited rare gas-halide lasers have been investigated theoretically, with particular emphasis on the KrF system. These studies have resulted in the identification of fundamental processes influencing electron energy transfer, charged particle production and loss, metastable production and loss, and plasma stability. Both electron beam pumped and discharge pumped lasers have been examined. In addition, resonance scattering theory has been applied to available e-F_2 attachment data in order to determine electron cross-sections for F_2 dissociative attachment and vibrational excitation. Estimates of direct electron impact dissociation of F_2 have also been made.

1276 (AD-A—041527) **Operation manual for CO probe laser for atmospheric studies.** Damon, E.K.; Thomas, M.E. May 1977. Contract N00173-76-C-0233. 48p. NTIS PC A03/MF A01.

No abstract available.

1277 (AD-A—041528) **CO probe laser for atmospheric studies. Final report 20 May 76—4 Mar 77.** Damon, E.K.; Thomas, M.E. May 1977. Contract N00173-76-C-0233. 17p. (ESL—4430-1). NTIS PC A02/MF A01.

The design, construction, and test in 8 of a CO probe laser is discussed. An electrically excited, flowing gas system was used. Output power of 360 mW was achieved in the 5-4 band, and 25 mW in the 3-2 band.

1278 (AD-A—041566) **Cl XI nozzle F_2 absorption experiment. Interim report.** Spencer, D.J.; Beggs, J.A. 15 Jun 1977. Contract F04701-76-C-0077. 24p. NTIS PC A02/MF A01.

An F_2-absorption diagnostic technique was developed to determine F_2 densities in the flow of a 10.2-cm-long TRW CL XI nozzle. The device was transported to the site, set up, tested, and returned to TRW in two days. Hence, the diagnostic device was demonstrated to be readily transportable and to be operable in a combustion-driven, chemical-laser field environment. Cold- and hot-flow measurements up to 970 K plenum temperature, i.e., no F_2 dissociation, were in agreement; therefore, this measurement appears to be reliable.

1279 (COO—4251-1) **Efficient high energy infrared third harmonic generation in gases and liquids for laser fusion applications. Quarterly progress report, March 1, 1977—May 31, 1977.** Kildal, H.; Brueck, S.R.J. Jun 1977. Contract ES-77-S-02-4251. 8p. Dep. NTIS, PC A02/MF A01.

During the first three months of the contract period the main effort has been directed toward optimizing the third harmonic (TH) conversion efficiency in liquid CO mixtures. For these experiments we have used a CO_2 pump laser with a 100 nsec pulse length. Substantial progress has been made in both increasing the conversion efficiency and understanding potential limiting processes. The highest TH power conversion efficiency obtained to date is 2 percent. A new stainless steel Dewar has been constructed with a 25 cm path length and a 1 cm I.D. This has been used in most of the experiments.

1280 (NTIS/PS—77/0598) **Light emitting diodes. Volume 1. 1964—May 1976 (a bibliography with abstracts). Report for 1964—May 76.** Reed, W.E. Jul 1977. 226p. NTIS PC N01/MF N01.

Studies on electroluminescent and semiconductor lasers are presented in the bibliography. Theory, design, applications, and materials are covered with applications including displays, optical communications, laser illuminators, signal processing, and avionics. (The updated bibliography contains 221 abstracts, none of which are new entries to the previous edition.)

1281 (NTIS/PS—77/0599) **Light emitting diodes. Volume 2. June 1976—June 1977 (a bibliography with abstracts). Report for Jun 76—Jun 77.** Reed, W.E. Jul 1977. 92p. NTIS PC N01/MF N01.

Studies on electroluminescent and semiconductor lasers are presented in the bibliography. Theory, design, applications, and materials are covered with applications including displays, optical communications, laser illuminators, signal processing, and avionics. (The updated bibliography contains 87 abstracts, all of which are new entries to the previous edition.)

1282 (NTIS/PS—77/0626) **Infrared upconversion (a bibliography with abstracts). Report for 1964—Jul 77.** Smith, M.F. Jul 1977. 97p. NTIS PC N01/MF N01.

Studies on device performance, materials, theory and applications are cited. Tunable lasers, infrared detection, crystal modulators and frequency converters are included. (The updated bibliography contains 92 abstracts, 24 of which are new entries to the previous edition.)

1283 (SAND—77-0775) **Evaluation of the potential to upgrade the Sandia Atomic Iodine Laser SAIL-1 to higher output energies.** Riley, M.E.; Palmer, R.E. May 1977. Contract EY-76-C-04-0789. 31p. Dep. NTIS, PC A02/MF A01.

The predicted output energy of the Sandia Atomic Iodine Laser SAIL-1 is given for various numbers of preamplifier stages and for various small signal gains in each stage. Additional possibilities for further increasing the output energy are given.

1284 **Near-atmospheric-pressure xenon excimer laser.** Turner, C.E. Jr. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). **31**: No. 10, 659-661(15 Nov 1977).

Oscillation at 172 nm for 200 nsec has been observed at a pressure of 1.5 atm of xenon with a 1-m length of gain medium pumped by a 200-kV 7-A/cm^2 1-μsec electron beam. The observed behavior agrees with calculations based on the excited-state mixing model for this new operating regime. The results support model predictions that a modest increase in excitation rate (about a factor of 2) would yield quasi-steady-state laser oscillation with an intrinsic efficiency near 5%, a fluence of ~1 J/cm^2, and a peak intracavity two-way flux of ~50 MW/cm^2. In optimized laser amplifier designs, significantly higher amplifier efficiencies should be possible.

1285 **Theoretical absorption spectra for Ne^+_2, Ar^+_2, Kr^+_2, and Xe^+_2 in the near ultraviolet.** Wadt, W.R.; Cartwright, D.C.; Cohen, J.S. (Theoretical Division, Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). **31**: No. 10, 672-674(15 Nov 1977).

Near-ultraviolet absorption spectra for the I(1/2)/sub u/ →II(1/2)/sub g/ transition have been calculated for Ne^+_2, Ar^+_2, Kr^+_2, and Xe^+_2 using ab initio configuration interaction methods. The spectra are all similar except that the position of maximum absorption shifts to longer wavelength for the heavier rare gases. The absorption cross sections are tabulated at the wavelengths of the KrF, XeBr, XeCl, and XeF lasers.

1286 **Injection locking of a xenon fluoride laser.** Goldhar, J.; Dickie, J.; Bradley, L.P.; Pleasance, L.D. (Lawrence Livermore

Laboratory, University of California, Livermore, California 94550). **31**: No. 10, 677-679(15 Nov 1977).

Operation of a XeF laser at high spectral power densities on transitions within a single vibrational band has been demonstrated. An electron-beam controlled discharge XeF laser was operated as an injection-locked regenerative amplifier. A narrow-band signal from an etalon-tuned XeF laser was used to lock the regenerative amplifier. Competition between the various components of the emission spectrum was observed. Homogeneous extraction is observed within each vibrational band, indicating that the rotational cross-relaxation time is substantially faster than the radiative lifetime of XeF. Coupling between vibrational bands was not observed. These measurements indicate that the efficient extraction from XeF on a single rotational transition should be possible. The band at 351 nm was found to consist of components arising from at least two different vibrational bands. The transitions in the 353-nm band and one component of the 351-nm band share a common vibrational level in the upper electronic state. These observations are consistent with current vibrational assignments of the XeF spectrum.

1287 Mercuric bromide photodissociation laser. Schimitschek, E.J.; Celto, J.E.; Trias, J.A. (Naval Ocean Systems Center, San Diego, California 92152). **31**: No. 9, 608-610(1 Nov 1977).

Laser action was achieved on the $B\ ^2\Sigma^+ \rightarrow X\ ^2\Sigma^+$ transition of the HgBr radical by photodissociating $HgBr_2$ in the vapor phase. The pump radiation was the 193-nm output of an ArF excimer laser. The measured laser wavelengths range from 502 to 505 nm. In transverse excitation, the measured output energy of the HgBr laser was 0.25 mJ at a pump energy of 7 mJ.

1288 Influence of diluent gas on the XeF laser. Champagne, L.F.; Harris, N.W. (Naval Research Laboratory, Washington, D.C. 20375). **31**: No. 8, 513-515(15 Oct 1977).

Substitution of neon for argon as the diluent gas in electron-beam-pumped XeF lasers allows increased optical extraction energies of 2.8 $J\ l^{-1}$ and efficiencies of 1.8%. The improved performance in neon diluent is due to a reduction of the optical absorption in the laser medium which occurs at the laser wavelength. This optical absorption is shown to be present when the rare gases along are irradiated.

1289 Theory of gain and saturation for collision-induced lasing transitions. Julienne, P.S. (Physical Chemistry Division, National Bureau of Standards, Washington, D.C. 20234). **48**: No. 10, 4140-4148(Oct 1977).

Theoretical expressions are given for the inversion density, small-signal-gain coefficient, and saturation-energy flux which pertain to stimulated collision-induced emission, that is, the free-free and free-bound dipole emission from unbound excited states formed during a collision of an atomic metastable species and another atom. The probability of stimulated emission during a collision is assumed to remain much less than unity so that a Maxwellian velocity distribution of excited atoms is maintained. The gain and saturation are described in terms of a profile function $k(\nu)$, a frequency-dependent two-body rate coefficient per unit frequency. The final expressions are analogous to those for a homogeneously broadened two-level atom. The theory is applied to the collision-induced green continuum from oxygen $^1S_0$ in argon.

1290 Volume-averaged rate equations for planar and disk-cavity lasers. Moreno, J.B. (Sandia Laboratories, Albuquerque, New Mexico 87115). **48**: No. 10, 4152-4162(Oct 1977).

Volume-averaged rate equations are formulated for both planar and disk-cavity lasers. These equations involve not only volume averages of the photon and population number densities, but also volume averages of products of these quantities, and the average over the reflecting surfaces of the incident photon flux. Closure relations for this open set are derived using exact solutions obtained from spatially dependent laser rate equations. The results show that over a wide range of conditions, above threshold, with reflectivities greater than 0.2, the usual spatially uniform rate equations are adequate for symmetric planar cavities. Falling below threshold, or towards smaller values of reflectivity, these equations are shown to be increasingly less accurate. Ultimately, simple closure relations do not suffice. For disk cavities, the exact solutions as well as the volume-averaged rate equation formulations are new. Radial gain profiles, and directional-intensity distributions at the mirror, are presented. Closure conditions for specular and diffuse-reflectivity models are given. As in the planar case, simple closure relations eventually fail to give an adequate description as reflectivities tend towards zero or operation falls below threshold.

1291 Spark photoionization of CO_2 laser gases. Ceglio, N.M.; Lawrence, J.D.; George, E.V. (Research Laboratory of Electronics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). **48**: No. 10, 4176-4182(Oct 1977).

An experimental investigation at atmospheric pressure of volume photoionization produced by bare sparks in He, CO_2, and N_2 gas mixtures containing tripropylamine is reported. Measurements were made using a probe and a pair of contoured collector electrodes with an applied dc potential. The variation of photoelectron density with gas mixture, tripropylamine addition, and uv source (spark) energy was investigated. Single-step photoionization of tripropylamine vapor was found to be the dominant ionization mechanism in this experiment. The addition of moderate amounts of tripropylamine vapor to gas mixtures containing CO_2 resulted in an increase of photoelectron density by more than an order of magnitude. The effects of gas mixture variation and tripropylamine addition on photoelectron temporal decay was studied and decay rates measured. The addition of tripropylamine to the gas mixtures was found to significantly increase electron decay rates. Measurements with a LiF window and a fused-quartz window were used to estimate the photoionization contributions from different portions of the spark spectrum. Short-wavelength radiation below the LiF cutoff appeared to be much more efficient for photoionization of the tripropylamine than that above the LiF cutoff. Radiation above the fused-quartz cutoff made no measurable contribution to the photoionization.

1292 System for amplifying laser beams. Hughes, J.L. US Patent 4,039,962. 2 Aug 1977. Filed date 14 May 1976. 6p.

A uni-directional laser amplifier system including a diverged beam having either a single unstructured pulse or a train of such pulses amplified to a very high power level over a long, folded amplification path is described. The beam emerges via a large, elliptical, cross-section aperture. The system includes two spaced rows of amplifying segments of elliptical and progressively increasing cross-sectional area with each segment having two polished non-parallel flat end surfaces with the front surface of each being anti-reflection coated and the rear surface having a laser mirror attached thereto or separated in conjunction with it by at least half the length of the laser pulse to be amplified. The segments are oriented at an angle of approximately 45° to the length of its row and at an angle of about 90° to the segments which follow in the amplifying sequence so that any pair of segments in the row with their front faces facing each other will reflect the diverged beam traversing the amplifier to a total angle of about 180° with the beam traversing each segment twice during this process. The system further includes optical excitation sources positioned along each row of segments matching their respective parameters in both size and power and separated from each other by a pair of segments which turn the beam to the 180° angle.

1293 Fast discharge, high power, electric discharge pumped gas laser. Wang, C.P.; Gibb, O.L. (to Aerospace Corp.). US Patent 4,039,971. 2 Aug 1977. Filed date 4 May 1976. 6p.

Laser emission from rare gas-halogen molecules, particularly krypton fluoride, is produced by a chemical reaction initiated by an efficient, high-power, high repetition-rate, fast electric discharge device transferring energy directly to a body of the gas in a laser cavity. The discharge device is of Blumlein parallel plate condensor/conductor types in which the condensor plates and their separating dielectric are uniformly compressed within an evacuated chamber by the force of the external atmospheric pressure.

1294 Solid state laser device with light filter. Shiroki, K.; Mori, K.; Kuwano, Y.; Saito, S. (to Nippon Electric Co., Ltd.). US Patent 4,039,970. 2 Aug 1977. Priority date 23 Mar 1973, Japan. 4p.

A laser device includes a solid state laser element consisting of a yttrium aluminate crystal and a source of pumping light. A light filter which intercepts and removes pumping light components having wave-lengths below about 5,000A is disposed between the laser element and the light source. The removal of these selected higher frequency components lowers the oscillation threshold value and increases the laser output.

1295 Closure of pinholes under intense laser radiation. Pearlman, J.S.; Anthes, J.P. (Sandia Laboratories, Albuquerque, New Mexico 87115). **16**: No. 8, 2328-2331(Aug 1977).

The closure of pinholes due to plasma created by intense laser radiation interacting with the pinhole perimeter is studied. Pinholes with 100—300-μm initial diam close in 3—14 nsec, respectively, for a 10-nsec FWHA, 10-J incident laser pulse. For a constant focal spot size and pulse duration, the closure time and rate are found to be a function of laser energy; however, the energy transmitted through the pinhole is independent of the incident energy for the pulse duration, pinhole diameters, and focal spot size used in these experiments.

1296 Active medium with specific output energy of 0.2 J/cm^3 in a photodissociation iodide laser. Danilov, O.B.; Korolenko, V.G.; Yachnev, I.L. **3**: No. 3, 82-83(Mar 1977).

Experiments are reported on the possibility of increasing the specific output energy of a perfluoralkyl iodide laser by dilution with perfluorohexane. (AIP)

1297 Recording of the space-time distribution of the energy density over the radiation field of a pulsed CO_2 laser. Zelenov, A.A.;

Kiseleva, K.A.; Petrova, L.I.; Semenov, E.P.; Yudintsev, E.M. **44**: No. 2, 105-106(Feb 1977).

A method is described that makes it possible to study the space-time distribution of the energy density over the radiation field of CO_2 lasers having a time resolution of 10^{-7} sec and a spatial resolution of 5-6 lines/mm over the image field.

1298 Lasers from fission (gaseous core reactors and nuclear pumped lasers for space power generation and transmission). Schneider, R.T. (US Office of Naval Research, London Branch Office); Thom, K. (National Aeronautics and Space Administration, Washington, D.C. (USA)); Helmick, H.H. (Los Alamos Scientific Lab., N.Mex. (USA)). pp 45-59 of In Space and energy. Napolitano, L.G. (Naples Univ. (Italy). Istituto di Aerodinamica). Oxford; Pergamon Press (1977).

From 16. international astronautical congress; Lisbon, Portugal (21 - 27 Sep 1975).

The energization of lasers directly by nuclear reactions has recently been achieved. In experiments conducted jointly by the University of Florida and Los Alamos Scientific Laboratory, New Mexico, a helium-xenon laser was directly pumped by fission fragments. The obtained laser wavelength was 3.5 μm. A group of researchers at the Sandia Corporation in Albuquerque, New Mexico, was successful in energizing a carbon monoxide laser by fission fragments at wavelengths in the 5-μm band. At the University of Illinois lasing was achieved at wavelengths of 8629 A and 9393 A in a neon-nitrogen mixture. A program of gaseous core reactor research is underway with experiments being conducted at the Los Alamos Scientific Laboratory in New Mexico, U.S.A. The program utilizes a beryllium moderator-reflector, forming a cylindrical cavity of 1 m dia and 1 m length. This system and associated control system hardware, uses components from the previous ROVER nuclear rocket program. Various configurations of canisters containing enriched gaseous uranium hexafluoride fuel are inserted into the reactor cavity for research on neutronics and nuclear induced optical radiation. Critical mass, control swing and the effects of poison were measured by simulating enriched uranium hexafluoride fuel with uranium foils, which were placed in homogeneous and inhomogeneous distributions in the cavity. Critical mass was determined at about 6 kg 93% enriched 235 uranium. A uranium hexafluoride canister system was built for safe operation in the reactor cavity and for physics measurements and observations at nuclear criticality. It is anticipated that this work will result in the demonstration of principles of a new type of nuclear power reactor, and of laser output from such a reactor.

1299 Possibility of employing the Borrmann effect in a gamma laser. Andreev, A.V.; Il'inskii, Y.A. (Moskovskij Gosudarstvennyj Univ. (USSR)). **70**: No. 5, 1713-1719(May 1976). (In Russian).

11 refs.; for English translation see the journal Sov. Phys. - JETP.

The efficiency of employing the Bragg diffraction for the amplification of restricted beams in finite crystals is considered. The conditions under which the plane incident wave approximation becomes invalid are determined. It is shown that in finite crystals modes may arise which propagate with a weak attenuation. Some numerical estimates are given.

1300 Compact truly mode-controlled TEA-CO_2-laser. Dufour, M.; Egger, H.; Seelig, W. (Bern Univ. (Switzerland). Inst. fuer Angewandte Physik). pp 114-116 of In International symposium on gasdynamic and chemical lasers. Fiebig, M.; Huegel, H. (eds.). Koeln-Porz, Germany, F.R.; DFVLR (1976).

From Symposium on gasdynamic and chemical lasers; Koeln, Germany, F.R. (11 - 15 Oct 1976).

2 refs. Short communication only.

1301 Model of the supersonic HF chemical mixing laser including turbulence effects on the chemistry. Kewley, D.J. (Southampton Univ. (UK). Dept. of Aeronautics and Astronautics). pp 212-223 of In International symposium on gasdynamic and chemical lasers. Fiebig, M.; Huegel, H. (eds.). Koeln-Porz, Germany, F.R.; DFVLR (1976).

From Symposium on gasdynamic and chemical lasers; Koeln, Germany, F.R. (11 - 15 Oct 1976).

6 figs.; 13 refs.

A computer model of the two-dimensional supersonic HF chemical mixing laser is presented. Calculations for a laminar mixing laser at 4 Torr agree with published results. For a turbulent mixing laser, the time-averaged chemical production rate of each species becomes a function of fluctuating species and temperature and, therefore, laminar chemistry is not valid. The concept of the 'typical eddy' is used to formulate more realistic turbulent chemistry terms. Preliminary results for a turbulent mixing laser are given for the case of fluctuating species but as yet without temperature fluctuations.

1302 Preliminary experiments with diffusers for a supersonic flow CO-laser. Krause, S. (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt e.V., Stuttgart (Germany, F.R.). Inst. fuer Plasmadynamik). pp 235-252 of In International symposium on gasdynamic and chemical lasers. Fiebig, M.; Huegel, H. (eds.). Koeln-Porz, Germany, F.R.; DFVLR (1976).

From Symposium on gasdynamic and chemical lasers; Koeln, Germany, F.R. (11 - 15 Oct 1976).

10 figs.; 1 tab.; 10 refs.

For practical applications it is imperative to minimize the pump system required for the operation of supersonic cw CO lasers by a suitable diffuser. The typically and unusually slender cross sections of the flow channels of such lasers require a new experimental investigation of conventional and novel diffuser geometries. Following a state-of-the-art survey of diffusers in general some preliminary results of such investigations with two types of diffusers are given. Because of the low density, the efficiency of the tested diffusers was so far relatively small.

1303 Emission-spectroscopic investigation of the F_2-H_2-system in a shock tube. Rimpel, G. (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt e.V., Stuttgart (Germany, F.R.). Inst. fuer Physikalische Chemie der Verbrennung). pp 419-440 of In International symposium on gasdynamic and chemical lasers. Fiebig, M.; Huegel, H. (eds.). Koeln-Porz, Germany, F.R.; DFVLR (1976). (In German)

From Symposium on gasdynamic and chemical lasers; Koeln, Germany, F.R. (11 - 15 Oct 1976).

7 figs.; 1 tab.; 20 refs.

In a shock tube Ar-F_2-H_2-mixtures, containing 0.2% F_2 and 0.2% H_2, were heated up to temperatures of appr. 830 resp. 940 K. The pressures amounted to 4.0 resp. 3.6 bar. The reaction between H_2 and F_2 was observed via the radiation emission of the vibrational excited HF-molecules. The spectral range from 660 to 960 nm was investigated. From these measurements it was possible to determine population numbers of discrete vibrational levels ($v = 3,...9$) of the HF-molecule. Chemical kinetic calculations were carried out in order to evaluate from these measurements informations on rate coefficients of certain elementary reactions. By adapting the calculations to the measurements it was found among others, that VVT-relaxation processes between HF and HF occur much faster at higher vibrational quantum numbers than it was supposed up to now. Furthermore, some preliminary results were obtained on VT-relaxation processes between HF and Ar as well as on the pumping reaction $H + F_2 \rightarrow HF + F$.

1304 Time resolved spectroscopy of a pulsed CO chemical laser pumped by the CS_2/NO_2 reaction. Rosenwaks, S. (Ben-Gurion Univ. of the Negev, Beersheba (Israel). Dept. of Chemistry). pp 441-447 of In International symposium on gasdynamic and chemical lasers. Fiebig, M.; Huegel, H. (eds.). Koeln-Porz, Germany, F.R.; DFVLR (1976).

From Symposium on gasdynamic and chemical lasers; Koeln, Germany, F.R. (11 - 15 Oct 1976).

3 figs.; 2 refs.

In the present work spectral and gain characteristics of the CO laser emission obtained from flash-photolysed CS_2-NO_2 mixtures were measured and analysed in order to understand the results of the preliminary experiments.

HEAT TRANSFER AND FLUID FLOW

REFER ALSO TO CITATION(S) 22, 701, 845, 1256

1305 Note on the centrifugal scaling of horizontal, isothermal, liquid-gas flows without mass transfer. Chesters, A.K. (Delft Univ of Technol, Neth). **3**: No. 3, 235-241(Mar 1977).

The use of rotation to simulate increased gravity in scale models of horizontal liquid-gas flows is examined. The influences of Coriolis forces and natural gravity in the model are seen to be small provided that high rotation rates are used, and large length scale-down factors can then be achieved.

1306 (SAND—77-1004C) Computational requirements for the three-dimensional flows. Blottner, F.G. 1976. Contract EY-76-C-04-0789. 10p. (CONF-771006—1). Dep. NTIS, PC A02/MF A01.

From Workshop on future computer requirements for computational aerodynamics; Moffett Field, California, USA (4 Oct 1977).

The computational requirements for the prediction of steady viscous flow over complex configurations are considered. These requirements include the attainment of sufficiently accurate results at a reasonable cost and with a reasonable storage time. A method is presented for estimating, within a 1% and 0.1% accuracy, the dollar cost and time required for performing 3-dimensional boundary layer computations on a CDC-7600 computer. (LCL)

1307 Monte Carlo time-dependent heat conduction with convective boundary conditions. Fraley, S.K. (Oak Ridge National Lab., TN). **26**: 237(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

1308 Hybrid method: finite differences vs finite elements. Coppari, L.A.; Thomas, J.R. Jr. (Virginia Polytechnic Inst. and State Univ., Blacksburg). **26**: 237-239(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

1309 Size distribution of vapor voids in boiling of a subcooled liquid inside a duct. Mironov, Y.V. **14**: No. 6, 1099-1104(May 1977).

An equation for the size distribution function of vapor voids in two-phase flow is discussed in connection with surface boiling of a subcooled liquid in ducts. An analytical solution is obtained for the initial boiling interval, neglecting aggregation and breakup of vapor voids. The lengthwise variations along the duct of the vapor content and quantity of heat transferred to the liquid in vapor void condensation are calculated. Correlation is obtained between the heat of condensation of the vapor voids, the vapor content, and the local subcooling of the liquid prior to boiling.

1310 Rate of particle fallout from a stream of condensed aerosol under nonisothermal conditions. Laricheva, M.A.; Mostinskii, I.L. (High-Temperature Institute, Academy of Sciences of the USSR). **14**: No. 6, 1111-1117(May 1977).

The fallout rate of submicron particles is experimentally determined for a stream of condensed aerosol flowing along and across an array of pipes. The significant effect of the thermophoresis forces on the process of formation of deposits is established for nonisothermal conditions. Good experimental agreement with theory is obtained.

1311 Wavy aspect of a horizontal co-current air-water film flow and the transport phenomena. Pimsner, V.; Toma, P. (Politech Inst, Bucharest, Rom). **3**: No. 3, 273-283(Mar 1977).

New experimental equations are developed for local void fraction, shear stress and net heat-transfer coefficient in a horizontal two-phase flowing system. Starting from statistically analyzed wavy film motion, a simplified model is constructed enabling the correlation of the observed transport phenomena. The analytical description is based on the well known "law of the wall" equations, thus offering a uique description of the system.

1312 Certain results from an experimental study of an accelerating two-phase nozzle with outflowing boiling fluid (potassium). Bakanov, Y.A.; Goncharov, B.A.; Kuznetsov, V.I.; Levin, A.A. (S. Ordzhonikidze Moscow Aviation Institute). **14**: No. 5, 949-956(Mar 1977).

Results of an experimental determination of the characteristics of a two-phase nozzle from which boiling potassium is outflowing are presented; the results were obtained for the range of flow rates 0.4-1.1 kg/sec, inlet temperature 900—1050°K, and outlet pressure below 0.25×10^5 N/m^2. The dynamic momentum of the outflowing fluid, and the efficiency and flow rate are determined as a function of the regime parameters. Nozzle efficiency with boiling potassium is at most about 0.7.

MATERIALS TESTING

1313 (AD-A—039997) **The placer: assembly and operation. Technical memo.** Goodwin, D.L. Apr 1977. 22p. (HDL-TM—77-7). NTIS PC A02/MF A01.

This report describes the assembly and operation instructions of the PLACER, a test system for discovering and locating electromagnetic-pulse shielding flaws in underground conduits.

1314 (LA-UR—77-1790) **Image restorations constrained by a multiply exposed picture.** Breedlove, J.R. Jr.; Kruger, R.P.; Trussell, H.J.; Hunt, B.R. 1977. Contract W-7405-ENG-36. 7p. (CONF-770844—3). Dep. NTIS, PC A02/MF A01.

From International optical computing conference; San Diego, California, USA (25 Aug 1977).

There are a number of possible industrial and scientific applications of nanosecond cineradiographs. While the technology exists to produce closely spaced pulses of x rays for this application, the quality of the time-resolved radiographs is severely limited. The limitations arise from the necessity of using a fluorescent screen to convert the transmitted x rays to light and then using electro-optical imaging systems to gate and to record the images with conventional high-speed cameras. It has been proposed that in addition to the time-resolved images, a conventional multiply-exposed radiograph be obtained. Simulations are used to demonstrate that the additional information supplied by the multiply-exposed radiograph can be used to improve the quality of digital image restorations of the time-resolved pictures over what could be achieved with the degraded images alone. Because of the need for image registration and rubber sheet transformations, this problem is one which can best be solved on a digital, as opposed to an optical, computer.

1315 High speed motion neutron radiography. Bossi, R.H. Corvallis, OR; Oregon State Univ. (1977). 169p. University Microfilms Order No. 77-14,061.

Thesis (Ph. D.).

A system to perform neutron radiographic analysis of dynamic events taking place over the order of several milliseconds was developed. The design consists of a TRIGA reactor capable of pulsing to 3000 MW peak power, a neutron beam collimator with an L/D of about 30:1, a lithium fluoride-zinc sulphide (LiF-ZnS) neutron scintillator screen, an image intensifier and a 16 mm high speed movie camera. The TRIGA reactor pulse and beam port collimator combine to yield a peak thermal neutron flux of about 4.2×10^{11} n/cm^2-sec at the object with a pulse width (FWHM) of 9 milliseconds. During this pulse duration sequential neutron radiographs are taken by the imaging system which detail any movement occurring in the object. The imaging system operates by converting the neutron signal to light, amplifying the light signal and recording the information on 16 mm Rapid Arts Recording film. LiF-ZnS neutron scintillator screens of 2/1 weight ratio of ZnS to LiF and 0.13 mm thickness constructed at OSU with sodium silicate binder are found to be very successful. The construction of the scintillators plus both an analytical model and experimental study of their performance is described.

VACUUM ENGINEERING

1316 Propagation velocity of cathode-initiated surface flashover. Anderson, R.A. (Sandia Laboratories, Albuquerque, New Mexico 87115). **48**: No. 10, 4210-4214(Oct 1977).

A polymethyl methacrylate insulator rod in vacuum is stressed by high-voltage pulses having 3-ns rise times, with the result that 40-mm-long incomplete discharges occur at the end of the rod. Time-resolved measurements of electron emission from different areas on the insulator surface indicate that a discharge propagates toward the anode at approximately 2×10^7 m/s during a pulse. A velocity of this order is expected if surface flashover results from an avalanche of electrons due to secondary emission at the insulator surface. Dependence of the velocity on the angle of the electric field relative to the insulator surface is predicted.

1317 Regulated particle-delivery system for vacuum furnaces. Schwab, M.; Rossow, T.L.; Mattson, G.E.; Parrish, W.H. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). **14**: No. 5, 1196-1200(Sep 1977).

A system for delivering a stream of particles into a vacuum furnance has been developed. Its chief features are: (1) closed-loop feedback to regulate the feed rate, (2) jam-free particle flow through the elimination of close tolerances in the mechanical design, and (3) an external reloading system that allows uninterrupted particle delivery without affecting vacuum operation. Feed rate is determined and controlled by measuring light scattered from a laser beam as it passes through the particle stream.

SOLID WASTE PROCESSING PLANTS AND EQUIPMENT

REFER ALSO TO CITATION(S) 404, 1093

1318 (NTIS/PS—77/0597) **Synthetic foods (a bibliography with abstracts). Report for 1964-Jul 77.** Lehmann, E.J. Jul 1977. 79p. NTIS PC N01/MF N01.

The bibliography covers the production and use of synthetic food for both human and animal consumption including high protein concentrates, whole foods, and supplements. Most of these foods are the result of synthesis from solid wastes such as cellulose, bagasse, and sludge. The use of algae as a protein source is also discussed. (This updated bibliography contains 72 abstracts, 12 of which are new entries to the previous edition.)

COMBUSTION SYSTEMS

REFER ALSO TO CITATION(S) 89, 91, 93, 95, 179, 182, 185, 388, 1071, 1240

1319 Use of the Milne-Eddington absorption coefficient for radiative heat transfer in combustion systems. Felske, J.D.; Tien, C.L. (Department of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, Mass.). **99**: No. 3, 458-465(Aug 1977).

The applicability of the Milne-Eddington absorption coefficient approximation is discussed in relation to the calculation of

radiative transport involving the two distinct types of species produced in combustion systems: gases and soot particles. The approximation is found to apply well to hydrocarbon soot particles and as a result analytical closed-form solutions are derived for the radiative heat transfer inside one-dimensional slab shaped soot clouds. (The applicability of the gray approximation to soot is also discussed.) For the calculation of total band radiation from gases, however, the Milne-Eddington approximation is found to be questionable. The meaning of its assumption is discussed in light of an established Curtis-Godson wide band scaling approximation. Its usefulness for real gases is then assessed through the calculation and comparison of slab radiation by both techniques.

1320 **Similarity criterion for a confined swirling jet system.** Steward, F.R.; Tennankore, K.N. (Univ. of New Brunswick, Fredericton). pp 1593-1609 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

A similarity criterion is proposed for a confined, isothermal, axisymmetric swirling jet system. This criterion has been derived in essentially two different manners, firstly by integrating the differential equations of motion under certain assumptions and secondly by considering the overall changes in the system. The criterion indicates that two dimensionless parameters, a Swirl Number and the Craya-Curtet number for confined swirling jets, characterize the system completely. Experimental investigations on such a confined, swirling jet system are also presented. The data indicate that essential features of the jet such as entrainment, radial profiles of axial velocity and decay of center-line velocity exhibit uniform behavior with variations in the value of the two parameters. Also, the static pressure variation along the wall of the confining duct is in qualitative agreement with the criterion. The experimental data are consistent with the theoretically derived similarity criterion for confined swirling turbulent jets.

1321 **Effect of plasma constitution on laser ignition energies.** Kingdon, R.G.; Weinberg, F.J. (Imperial Coll. of Science and Tech., London). pp 747-756 of In Sixteenth symposium (international) on combustion. Pittsburgh; Combustion Institute (1977).

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

See CONF-760801—.

The extent to which minimum ignition energies depend on the species which carry the plasma energy is investigated, with particular reference to inhibitors and to the usual constituents of electrodes used in spark ignition. The fundamental limitations which apply to ignition by laser beams focused into gases are avoided by using minute targets in the form of wires or fibers of the order of 10^{-5} m in diameter. The extent of the plasma can be varied by defocusing. Its energy is measured by a specially developed suction microcalorimeter. It is found that, for Q-switched pulses of about 40 ns duration, minimum ignition energies are independent both of the carrier material constitution and of the amount of foreign substance in the plasma in accord with the underlying propagation-limited theory. For much longer durations however, of the order of 1 ms, plasma constitution plays the role expected from each additive. Thus inhibitors, for example, inhibit if the continuing energy input enables them to catch up with the expanding flame fronts.

UNDERGROUND ENGINEERING

REFER ALSO TO CITATION(S) 1561

1322 (PB—266764) **Analysis of noncoal mine atmospheres. Final report.** Rodgers, S.J. 21 May 1976. Contract S0231057. 121p. NTIS PC A06/MF A01.

The quantity and behavior of gases in metal and nonmetal mines were monitored to provide background information on feasibility of incipient fire detection systems. Monitoring was conducted during working and nonworking periods at intake air, return air, and working places. Gases generated during diesel operations and shot firing were of particular interest. Gases that were monitored were CO, CO2, NO, NO2, and SO2. Submicrometer particulate concentrations were also monitored. Commercially available instruments were used and included nondispersive infrared, electrochemical, and chemiluminescent types. The ratios of the various gases generated during diesel operations and shot firing were similar to those expected from an incipient fire, except for the CO2/NOx ratio, which was sufficiently different to be considered for early fire warning. Samples taken near leaking bulkheads showed high CO2 levels, and low CO levels, the reverse of anticipated behavior in coal mines.

MARINE ENGINEERING

REFER ALSO TO CITATION(S) 459, 461

POLLUTION CONTROL EQUIPMENT

REFER ALSO TO CITATION(S) 64

1323 (COO—1248-54, pp 53p, Part II) **Fundamental studies on electrostatic precipitation.** Pui, D.Y.H.; Liu, B.Y.H. Jul 1977.

In Electrical charging of small particles at low pressures.

A study was undertaken to determine the performance characteristics of a single-stage, wire-in-tube electrostatic precipitator. The objective of the study was to perform detailed experiments on the device so that the data obtained could be used as the basis for comparison with the available precipitator theories. In spite of the use of electrostatic precipitators in industry for many years, experimental data of a sufficiently fundamental nature are lacking. The experiments described in this report have been made possible by the recent development of a monodisperse aerosol generator and a new electrical aerosol detector by means of which the efficiency of a precipitator can be measured from about 0.03 to 1.0 μm particle diameter over a wide range of operating conditions. The experimental systems used and results obtained are described. Some preliminary comparisons with available theories are also given.

1324 (COO—1248-54, pp 14p, Part III) **Laser Doppler velocimeter for measuring the aerodynamic size of particles.** Wilson, J.C.; Liu, B.Y.H. Jul 1977.

In Electrical charging of small particles at low pressures.

The object of this project is to investigate the use of a laser Doppler velocimeter for measuring the aerodynamic size of particles in the 0.5 μm to 10 μm diameter range. In addition, the project is to provide information needed in the design of the flow and velocity measuring components of a practical instrument for aerodynamic size determinations.

BRAYTON

REFER ALSO TO CITATION(S) 915

PARTICLE ACCELERATORS

DESIGN, DEVELOPMENT, AND OPERATION

1325 (AD-A—039769) **Final report to Office of Naval Research contract N00014-75-C-0786. Report for Mar 1975—Feb 1976.** Jan 1977. 15p. NTIS PC A02/MF A01.

The work on superconducting cavity development under contract to the Office of Naval Research has provided those working in this field at HEPL with an exciting and productive time, and this work has contributed immeasurably to the superconducting accelerator project at HEPL. The pioneering superconducting cavity development effort at HEPL with its excellent results encouraged other groups in the United States and in other countries (West Germany, Japan, Great Britain and France) to begin programs in developing superconducting cavities. Although the principal interest in superconducting cavities was for use in particle accelerators, other applications have been seriously studied. These include rf particle separators, high stability oscillators, very high power pulsed radar sources, electro-mechanical energy conversion for microwave power transmission, high voltage electron microscopes, and rf confinement of fusion plasmas.

BEAM DYNAMICS, FIELD CALCULATIONS, AND ION OPTICS

1326 **Maximum current of relativistic electron beams in vacuum channels.** Nechaev, V.E. (Scientific-Research Radiophysical Institute, Gor'kii). 3: No. 1, 64-67(Jan 1977).

The maximum currents of solid (strongly magnetized and Brillouin) and annular relativistic electron beams are analyzed and compared. A numerical calculation of the maximum current of a strongly magnetized beam is reported. Since the energy stratification of such beams is too extreme, the concept of the useful current is introduced, and rough calculations of this useful current are carried out on the basis of the permissible stratification. When the maximum current is reached in a solid Brillouin beam, the greater part of the energy is associated with the rotation of the beam. The pronounced increase in the density toward the periphery poses difficulties for

beam formation. The maximum current is found for a thin tubular beam near the wall, bounded by a strong magnetic field which overcomes the electron repulsion. A corresponding equation is derived for the absolute maximum current in a vacuum channel as a function of the tube potential and of the external magnetic field.

INSTRUMENTATION

RADIATION INSTRUMENTATION

GENERAL DETECTORS AND MONITORS

REFER ALSO TO CITATION(S) 1374

1327 (AD-A—039802) **Nuclear effects analysis DI-S-1800 aerial radiac system AN/ADR-6(XE-4) (v).** 21 Dec 1972. Contract DAAB07-72-C-0202. 79p. (NA—72-1101). Microfiche copies only.

This preliminary report summarizes the analysis effort performed to date on the Aerial Radiac System (ARS) to assure proper ARS operation following exposure to nuclear radiation. To facilitate the analysis effort, the ARS has been subdivided into several subcircuits. Each subcircuit will be analyzed and/or tested to assure proper performance following exposure to radiation at specification level. The ARS is used to measure ground dose radiation level (Rads/hr). The Power Supplies convert aircraft 28 volts dc to regulated +15 and -15 volts dc and -1000 volts dc. Gamma dose rate is measured by the Photomultiplier Tube and converted to a voltage level by a log amplifier. This voltage when scaled by EMAX in the subtractor circuit becomes the air dose level. The Ground Dose Computer provides the ground dose level by combining a signal proportional to the altitude as furnished by a radar altimeter with the air dose level signal. The ground dose level signal is displayed, recorded and/or can be telemetered. A self test feature is also provided.

1328 (COO—323-37) **Investigation of cables for ionization chambers.** Spokas, J.J. 1976. Contract EY-76-S-02-0323. 22p. (CONF-761153—4). Dep. NTIS, PC A02/MF A01.

From 62. annual meeting of radiologic advances in breast cancer; Chicago, Illinois, United States of America (USA) (15 Nov 1976).

Nine coaxial cables which have been proposed or are presently being used for carrying the currents generated in ionization chambers have been critically studied with reference to their suitability to this application. Included in this study are four low-noise triaxial cables, three low-noise two-conductor cables, and two of other types of cables. For each cable the following characteristics were determined: inherent noise currents, currents produced by cable movements, polarization currents, the degree of electrostatic shielding of the central signal-carrying conductor, and radiation induced cable currents. This study indicates that two low-noise triaxial cables, both employing Teflon dielectric surrounding the central conductor, offer the best overall performance for use with ionization chambers.

1329 (EGG—1183-1687) **HP 65 computer program for calculating discrete source detectability.** Stuart, T.P. 13 Apr 1976. Contract EY-76-C-08-1183. 27p. Dep. NTIS, PC A02/MF A01.

This memo addresses the problem of calculating detectability of discrete γ-ray sources as a function of γ-ray energy, detector size, speed of search platform, angular response of detectors, shielding between source and detector, temporal data processing techniques, and background contributions from natural γ-ray emitters in the environment. The equations are derived and the computer code described. The calculation method can be used with the Surveillance Accident Nuclear Detection System (SANDS), which contains two arrays of 20 each, 5-inch diameter by 2-inch thick NaI crystals, flown in a helicopter. (WHK)

1330 (LA—6843-MS) **Design and performance of a heavy ion detector using a gridded ionization chamber with helical position-sensitive proportional counter.** Orbesen, S.D.; Flynn, E.R.; Hanson, D.L.; Sunier, J.W. Jun 1977. Contract W-7405-ENG-36. 7p. Dep. NTIS, PC A02/MF A01.

A counter specifically designed for heavy ions and low-energy helium ions has been constructed for use in the focal plane of a Q3D spectrometer. The counter utilizes a gridded ionization chamber to measure energy loss and total energy of the particles incident on the detector and a helical proportional chamber to establish the position and hence the momentum along the focal plane. The ionization chamber information is used to establish the mass and charge of the incident particle with high precision and under low background conditions. The helix provides excellent spatial resolution along with high counting rate performance and a resolution independent of the angle at which the particles enter the detector.

1331 (LA—6860-MS) **Portable survey instrument for low levels of transuranic contaminants.** Wolf, M.A. Jul 1977. Contract W-7405-ENG-36. 12p. Dep. NTIS, PC A02/MF A01.

A fully portable survey instrument for low levels of transuranic nuclides has been designed. The design takes advantage of the properties of a phoswich scintillator to detect low-energy photons and discriminate against higher energy Compton-scattered events.

1332 (SAND—77-8621) **Microchannel plate response to hard x-rays.** Dolan, K.W.; Chang, J. Mar 1977. Contract EY-76-C-04-0789. 14p. (CONF-770434—4). Dep. NTIS, PC A02/MF A01.

From SPIE x-ray imaging symposium; Reston, Virginia, United States of America (USA) (20 Apr 1977).

The current response and the pulse response of a microchannel plate, MCP, to x-rays incident at an angle of 45° in the energy range of 8 to 100 keV were measured. The x-ray detection efficiency, pulse height distributions, and sensitive depth of the MCP were determined from these data. Detection efficiency extrapolates to zero below 8 keV, and ranges between values of 1% and 2.6% above this energy, much higher than anticipated from previous measurements for oblique incidence below 6 keV. When compared to previous measurements at higher energies, it is concluded that MCP's have a relatively constant detection efficiency in the energy range 10 to 600 keV, which is a rather unique property as compared to other x-ray detectors. It was found that the shape of current response curves differs somewhat from the shape of efficiency curves, that pulse height distributions are proportional to pulse height to the -1.1 to -1.6 power, and that 90% of the current originates in the first 25 to 30% of the MCP thickness.

1333 **Far-infrared photoconductivity of uniaxially stressed germanium.** Kazanskii, A.G.; Richards, P.L.; Haller, E.E. (Department of Physics, University of California, and Materials and Molecular Research Division, Lawrence Berkeley Laboratory, Berkeley, California 94720). **31**: No. 8, 496-497(15 Oct 1977).

The influence of uniaxial stress on the extrinsic photoconductivity of gallium-doped germanium has been investigated. It has been found that the long-wavelength cutoff is shifted from 114 μm for zero stress to 200 μm for a uniaxial stress of 6.6×10^3 kg/cm² along a [100] direction. At this value of stress the responsivity was $\sim 2 \times 10^4$ V/W and the NEP was $\sim 2 \times 10^{-11}$ W/Hz/sup 1/2/ at 190 μm.

1334 **Clinical high-purity germanium gamma camera.** Ewins, J.H.; Armantrout, G.A.; Camp, D.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.); Kaufman, L.; Hattner, R.S.; Price, D.C.; Lorenz, V.S. (California Univ., San Francisco (USA)); Hosier, K.E.; Lee, K.L. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). pp v.1 p.149-157 of In Medical radionuclide imaging. Vienna; IAEA (1977).

From International symposium on medical radionuclide imaging; Los Angeles, Calif., USA (25 - 29 Oct 1976).

The need in clinical nuclear medicine for imaging devices with high spatial resolution has been discussed at length for many years. More recently, specialists in cardiology and neurology have restated this need for greater resolution in order to effect earlier or more accurate diagnoses of brain tumours, cerebral and myocardial ischaemia and infarcts and septum defects, among others. Our approach to filling this need is to ultimately develop a 3072-element, high-purity germanium camera with a 2-mm spatial resolution, an energy resolution of 2 to 3% for ^{99}Tcsup(m), and a clinically useful area of 123 cm² for imaging the average adult heart, breast or brain. To this end, a 100-element prototype has been constructed and images of rats and mice have been obtained with the use of single and multiple isotopes. A second prototype with 512 elements has also been completed and tested. The 512 elements are derived from an array of electrodes, on the bottom of two germanium crystals, orthogonal to 16 electrodes on the top. The top electrodes are electrically in parallel and have a common electronic readout. The p-contact is palladium over germanium oxide, and the n-side is gold over the lithium diffusion. Cooling for the detector is accomplished through a sapphire motherboard by way of indium contacts which are also the electrical contacts for the n-side. The isolation between the strips on the p- and the n-sides are adequate to attain good energy resolution.

1335 (ORNL-tr—4408) **Barrier-layer counters for the registration of position and energy.** Lauterjung, K.H.; Pokar, J.; Schimmer, B.; Staeudner, R. Translated by J. Lee from **22**: 117-121(1963). 9p. Dep. NTIS, PC A02/MF A01.

Solid state radiation detectors with suitable contacts produce pulses with a rise time depending on the position of the entering particle. The slope of these pulses, which is independent of the position, is proportional to the energy of the particle. These two properties are used for the simultaneous registration of position and energy.

RADIATION DOSEMETERS

1336 (UCRL—79633) **Neutron dosimetry studies at the Lawrence Livermore Laboratory.** Hankins, D.E. 22 Jun 1977. Contract W-7405-ENG-48. 24p. (CONF-770726—3). Dep. NTIS, PC A02/MF A01.

From 6. workshop on personnel neutron dosimetry; Oak Ridge, Tennessee, USA (11 Jul 1977).

Work performed since the last Workshop meeting is summarized. The studies have been divided into the following sections: (1) response of albedo neutron dosimeters to low energy neutrons; (2) discussion of dose-equivalent conversion factors; (3) modification of the A-B remmeter; (4) the effect of distance from the body on the response of albedo neutron dosimeters; (5) comparison of albedo neutron dosimeter techniques; and (6) modified NAD badge for additional beta shielding and albedo neutron dosimetry.

1337 (UCRL-Trans—11248) **Modern methods of personnel dosimetry.** Kraus, W.; Herrmann, D.; Kiesewetter, W. May 1977. Translation of SZS—6/66. 72p. Dep. NTIS, PC A04/MF A01.

The physical properties of radiation detectors for personnel dosimetry are described and compared. The suitability of different types of dosimeters for operational and central monitoring of normal occupational exposure, for accident and catastrophe dosimetry and for background and space-flight dosimetry is discussed. The difficulties in interpreting the dosimeter reading with respect to the dose in individual body organs are discussed briefly. 430 literature citations (up to Spring 1966) are given.

1338 **Photographic polymeric composition containing a leuco dye cyanide.** McLaughlin, W.L.; Levine, H.; Rosenstein, M. US Patent 4,006,023. 1 Feb 1977. Filed date 7 Oct 1974. 9p.

A hard, clear, glassy, smooth polymer with a dry surface having a dye precursor therein which forms a permanent color at those areas of the solid polymer that have been irradiated with ultraviolet or ionizing radiation is formed by combining vinyl and/or acrylic monomers, a triphenylmethane cyanide dye precursor and a chemical initiator that is compatible with the dye cyanide and polymerizing in the presence of a slight excess of hydrogen ions in an inert atmosphere.

NUCLEAR SPECTROSCOPIC INSTRUMENTATION

REFER ALSO TO CITATION(S) 232, 1330

1339 (UCID—17572) **LSI-11 based pulse height analyzer.** Bourret, S.C. 31 Aug 1977. Contract W-7405-ENG-48. 7p. Dep. NTIS, PC A02/MF A01.

A remote-local controlled 4K channel, 32 bits per channel pulse height analyzer (PHA) built around a Fortran programmed LSI-11 is described. The PHA is made up of an LSI-11 microcomputer with 20K of memory, an interface to a Northern Scientific ADC, an 8 bit parallel link to a master LSI-11 computer, and a serial 9600 baud link to a shared DEC VT55 graphics terminal. There are 4 PHAs all networked to a remote master computer that make up the total PHA system. This PHA system will gather X-ray and γ-ray spectra data from neutron activated rabbit samples for the Lawrence Livermore Laboratory NURE project. NURE is an acronym standing for the National Uranium Resource Evaluation. The goal of NURE is to conduct a multidisciplinary survey of the uranium mineral resources in the United States and publish an assessment of the national uranium reserves by mid-1981. The purpose of LLL's part is to process the samples taken from the western 1/4 of the U.S. and publish the results. A secondary purpose of the analysis is to identify any other elements in the sample for future reference.

RADIOMETRIC INSTRUMENTS

REFER ALSO TO CITATION(S) 1339, 1350

RADIATION EFFECTS ON INSTRUMENT COMPONENTS, INSTRUMENTS, OR ELECTRONIC SYSTEMS

1340 (AD-A—039835) **Truncation of the distribution of parts failures by screening. Final report.** Chronister, R.D.; Maier, R.J. Mar 1977. 38p. (AFWL-TR—76-247). NTIS PC A03/MF A01.

The value of acceptance test screening as a quality assurance tool is explored from the viewpoint of radiation hardness assurance. Since parts failures that occur due to the application of extreme environments such as radiation can most frequently be described using the normal distribution, the bivariate normal distribution is assumed. Numerical and graphical tabulations of the distribution failures are presented for various screening levels below which all parts are rejected. In this report the calculations required to evaluate acceptance test screening as a radiation hardness assurance tool are explained and the methods of estimating the error resulting from assuming normal distribution detailed. Examples are given to show that poorly correlated screens are nevertheless useful for radiation hardness assurance when extreme readiation levels are not anticipated and that hardening by screening is unproductive when high radiation levels are anticipated.

1341 (NTIS/PS—77/0485) **Integrated circuit reliability. Volume 1. 1964—Mar 1976 (a bibliography with abstracts). Report for 1964—Mar 1976.** Reed, W.E. Jun 1977. 235p. NTIS PC N01/MF N01.

The bibliography presents research pertinent to design, reliability prediction, failure and malfunction, processing techniques, and radiation damage. (This updated bibliography contains 230 abstracts, none of which are new entries to the previous edition.)

1342 (NTIS/PS—77/0486) **Integrated circuit reliability. Volume 2. April, 1976—May, 1977 (a bibliography with abstracts). Report for Apr 1976—May 1977.** Reed, W.E. Jun 1977. 106p. NTIS PC N01/MF N01.

The bibliography presents research pertinent to design, reliability prediction, failure and malfunction, processing techniques, and radiation damage. (This updated bibliography contains 101 abstracts, all of which are new entries to the previous edition.) See also NTIS/PS-77/0485, Integrated Circuit Reliability. Vol. 1. 1964-March, 1976.

MISCELLANEOUS INSTRUMENTS

REFER ALSO TO CITATION(S) 81, 82, 94, 178, 1197, 1361, 1362, 1371, 1478, 2026

1343 (CONF-770642—12) **Ion microprobe using a field evaporation ion source fed by liquid gallium.** Ringo, G.R.; Krohn, V.E. 1977. Contract W-31-109-ENG-38. 8p. Dep. NTIS, PC A02/MF A01.

From 3. international conference on ion beam analysis; Washington, District of Columbia, United States of America (USA) (27 Jun 1977).

A scanning ion microprobe with a resolution of 15 nm or better appears to be quite possible on the basis of a field-evaporation (EHD) ion source that has been developed and a high efficiency system for production and collection of negative secondary ions. The possibilities of still better systems for the analysis of the secondaries using either stopping-power or laser-induced-fluorescence methods of identification are discussed briefly.

1344 (SAND—77-8009) **Time correlation of FM data in the Data Processing Division.** Kelley, R.W. May 1977. Contract EY-76-C-04-0789. 60p. Dep. NTIS, PC A04/MF A01.

During development testing, large amounts of data are recorded by analog tape instruments for later analysis. Time correlation between the various data channels is often important but usually difficult to achieve. The amount of phase error that occurs is a function of the dissimilarities in delay from channel to channel. Delays are introduced by various filters used in the record and reproduce electronics and depend to some extent on the user's ability to make an intelligent selection of the filters available. Mechanical factors, such as head gap alignment and tape dimensional changes, also affect time correlation. This report identifies the major sources of timing errors occurring in multichannel recording and reproduction. Recommendations are made for selection of recording and processing techniques to minimize these errors.

1345 **NMR probe for combined homonuclear multiple pulse decoupling and magic angle spinning.** Pembleton, R.G.; Ryan, L.M.; Gerstein, B.C. (Ames Laboratory-ERDA and Department of Chemistry, Iowa State University, Ames, Iowa 50011). **48**: No. 10, 1286-1289(Oct 1977).

An NMR probe is described which is capable of use in combined multiple pulse—magic angle spinning experiments for removal of homonuclear dipolar broadening and chemical shift anisotropies in randomly oriented samples. Two examples are included to illustrate the utility of the technique.

1346 **Aging of optical properties of polished copper mirrors.** Lester, R.S.; Saito, T.T. (University of California, Lawrence Livermore Laboratory, Livermore, California 94550). **16**: No. 8, 2035-2036(Aug 1977).

The reflectivity of copper mirrors as a function of mirror age was measured for three different polishing techniques. Radiation of 10.6 μm and 0.63 μm was employed.(AIP)

1347 **Simultaneous three element x-ray mapping using color TV.** Pawley, J.B. (Univ. of California, Berkeley); Hayes, T.; Falk, R.H. pp 186-194 of In Scanning electron microscopy. I. Chicago; IIT Research Inst. (1976).

From 9. annual scanning electron microscope symposium; Chicago, IL, USA (Apr 1976).

This study introduces an X-ray device capable of simultaneously mapping three elements in three different colors. Such mapping is desirable because it permits the collection and display of information about several elements simultaneously rather than by sequential scans. Simultaneous mapping at TV rates provides savings in time and reduction of radiation dose, two factors particularly important for studies of biological materials. The three elemental distributions are displayed in a single image where important relationships between the various elemental concentrations can be seen. The present system utilizes an energy dispersive X-ray detector and standard preamplifier. The amplifier and pulse height analyzer design recognizes the importance of a short shaping constant and a rapid method for pulse height testing. Three single channel analyzers with their emerging pulses gated by a strobe output for uniform delay time provide the three individual pulse height windows, one for each of the three elements being mapped. If a peak is found in a window it can be sensed and passed on to the multi-channel analyzer coincidence input so that the peaks only in the single channel analyzer windows will be displayed. The image is recorded on Polaroid color film using a 4" x 5" camera fitted with an oscilloscope lens and capable of recording the shadow mask tube image.

WELL LOGGING INSTRUMENTATION

1348 (NTIS/PS—77/0635) **Electric automobiles (citations from the NTIS data base). Report for 1964—Jul 77.** Hundemann, A.S. Aug 1977. 158p. NTIS PC N01/MF N01.

Abstracts of Federally-funded research pertaining to battery systems, costs, and evaluations of electric vehicles are presented. Studies are included on nickel-zinc and lead-acid batteries, various types of lithium cells, and hybrid heat engine/electric systems. (The updated bibliography contains 153 abstracts, 54 of which are new entries to the previous edition.)

1349 (UCRL-Trans—11261) **Logging, testing, perforation, and shooting of boreholes.** Shakirov, A.F. Jul 1977. Translated from pp 5-52 and table of contents of Karotazh ispytanie, perforatsiya i torpedirovanie skvazhin, Nedra Press, Moscow, USSR, 1972. 114p. Dep. NTIS, PC A06/MF A01.

This book is divided into six parts dealing with: geophysical methods of investigating boreholes during drilling and completed boreholes; direct methods of studying geological section of boreholes (sampling, testing); geophysical methods of checking technical state of boreholes and oil fields and well operation; shooting and blasting work in boreholes; geophysical instruments and equipment; and organization and execution of geophysical operations. (DLC)

1350 (UCRL-Trans—11260) **Density gamma—gamma logging in ore deposits (methodological recommendations).** Artsybashev, V.A.; Ivanyukovich, G.A. Jul 1977. Translation of Plotnostnoy gamma-gamma-karotazh na rudnykh mestorozhdeniyakh, Atomizdat, Moscow, 1975. 105p. Dep. NTIS, PC A06/MF A01.

Density gamma-gamma logging (DGGL) is one of the leading geophysical methods of studying the geological section in boreholes. It is used widely in coal fields and oil fields, and to a smaller extent in ore deposits. Topics discussed include physical principles of the method, DGGL apparatus, calibration of apparatus, analysis of interference factors, principles of measurement procedures, and principles of the interpretation of DGGL diagrams. (WHK)

1351 **Investigating probe polarizing field of nuclear magnetic logging.** Aksel'rod, S.M.; Danevich, V.I.; Mityushin, E.M.; Khaimov, I.Ya. (Vsesoyuznyj Nauchno-Issledovatel'skij Inst. Geofizicheskikh Metodov Razvedki, Baku (USSR)). No. 81, 170-180(1976). (In Russian).

4 refs.; for English translation see the journal Explor. Geophys.

The study is concerned with the polarizing field of a nuclear-magnetic coil with finite geometric dimensions of the winding. An assessment is made regarding the possibility of idealizing the winding form. A general comparison is given for the polarizing field of the probe with finite geometric dimensions. An analysis of the nuclear-magnetic coil probe fields was performed by this equation to show the possibility of disregarding the input of the coil short sides. It was also shown that a probe coil in the form of an annular sector (2 delta = 120 deg) provided the most profound insight into the problem possibility of using interpretation pallets calculated in allowing for a distance-dependent quadratic variation in the polarizing field voltage.

EXPLOSIONS AND EXPLOSIVES

REFER ALSO TO CITATION(S) 1560

CHEMICAL

REFER ALSO TO CITATION(S) 1412, 1561

NUCLEAR

REFER ALSO TO CITATION(S) 1412

1352 (AD-A—039657) **Asymptotic conical dipole D-dot sensor (ACD-S1(R)) development. Final report.** Olsen, S.L. Apr 1976. Contract F29601-75-C-0085. 47p. NTIS PC A03/MF A01.

This report describes the development of a small, D-dot sensor. The sensor shape is determined from the field distributions around a postulated line charge protruding from and normal to a conducting surface. It produces a voltage output in response to a time variant E-field. The theory of operation, modeling experiments, design and construction, prototype testing and test results are discussed within.

1353 (AD-A—040058) **Charts for preliminary design of deep underground structures subjected to dynamic loads. Final report Jan 1975—Jun 1976.** Britt, J.R. Apr 1977. 78p. (WES-MP-N—77-3). NTIS PC A05/MF A01.

This report presents charts suitable for preliminary dynamic design of deep underground protective structures in rock subjected to long-duration ground shock loadings produced by nuclear weapons. The charts were calculated using a theoretical model which consists of multilayered concentric cylinders of elastoplastic materials with a time-dependent, axially symmetric applied load representing the free-field stress. Each element in the cross section is assumed to be incompressible and its yield is governed by a Monro-Coulomb failure criterion. A first-order correction factor is given to account for compressibility of the materials.

1354 (SAND—77-8256) **Analytical model of a single axis attitude roll control system.** Rogers, M.H. Jun 1977. Contract EY-76-C-04-0789. 81p. Dep. NTIS, PC A05/MF A01.

The B77 weapon system currently under development at Sandia Laboratories, Livermore, California, uses a reaction system to control the roll attitude of the vehicle during flight. This thesis describes the development of a mathematical model used to predict the performance of this roll control system. In addition, the implementation of this model on a digital computer is discussed along with a comparison of predicted system performance versus observed performance.

ENVIRONMENTAL SCIENCES, ATMOSPHERIC

1355 (ERDA—1200(75)) **Research contracts in the life sciences.** 1 Jul 1975. 114p. Dep. NTIS, PC A06/MF A01.

Research studies during 1975 in the fields of health, biology, environment, and related studies that received financial aid from ERDA are listed by institution and location. The title of the study, principal investigator, and annual level of financial aid are included.

BASIC STUDIES

REFER ALSO TO CITATION(S) 1364, 1395, 1414

1356 (COO—1248-54, pp 31p, Part I) **Combined field and diffusion charging of aerosol particles in the continuum regime.** Liu, B.Y.H.; Kapadia, A. Jul 1977.

In Electrical charging of small particles at low pressures.

An aerosol particle exposed to unipolar ions in an electric field acquires charge due to the thermal motion of ions and due to the motion induced on the ions by the applied electric field. The amount of charge acquired by the particle depends upon the charging time, the gaseous ion concentration, the particle diameter, the magnitude of the electric field, and, to a lesser extent, on the dielectric constant of the particle, the nature of the ions, and the temperature at which charging takes place. The rate of charging of particles and the amount of charge acquired by them is useful in the design of electrostatic precipitators and in particle sizing and count-

ing instruments using the amount of charge acquired by the particles after they are passed through a charger. The purpose of this paper is to describe some recent work on the subject of combined field and diffusion charging in which the basic equation governing the diffusion of ions in an electric field is solved by a numerical, iterative scheme. The result is believed to be exact in so far as combined charging in the continuum regime is concerned, i.e., in the regime in which the ion mean free path is small compared to the particle radius.

1357 Empirical eigenvector analysis of vector observations. Hardy, D.M. (Lawrence Livermore Laboratory, University of California, Livermore, CA 94550). **4**: No. 8, 319-320(Aug 1977).

A method of deriving an empirical eigenvector or principal components representation of wind velocity measurements is given. The mathematical basis for generalizing the empirical eigenvector method to the treatment of vector data fields is stated briefly. The method presented can be employed in the analysis of regional wind velocity patterns. Applications of the analysis technique to other geophysical vector fields are also possible.

1358 Verification of some numerical models for operationally predicting mesoscale winds aloft. Cornett, J.S.; Randerson, D. (National Weather Service—Nuclear Support Office, Las Vegas, Nev. 89114). **16**: No. 8, 764-773(Aug 1977).

Four numerical models are described for predicting mesoscale winds aloft for a 6 h period. These models are all tested statistically against persistence as the control forecast and against predictions made by operational forecasters. Mesoscale winds aloft data were used to initialize the models and to verify the predictions on an hourly basis. The model yielding the smallest root-mean-square vector errors (RMSVE's) was the one based on the most physics which included advection, ageostrophic acceleration, vertical mixing and friction. Horizontal advection was found to be the most important term in reducing the RMSVE's followed by ageostrophic acceleration, vertical advection, surface friction and vertical mixing. From a comparison of the mean absolute errors based on up to 72 independent wind-profile predictions made by operational forecasters, by the most complete model, and by persistence, we conclude that the model is the best wind predictor in the free air. In the boundary layer, the results tend to favor the forecaster for direction predictions. The speed predictions showed no overall superiority in any of these three models.

RADIOMETRIC TECHNIQUES

REFER ALSO TO CITATION(S) 1374

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 68, 1323, 1324, 1534

1359 (BNL—22879) **Meteorological and chemical relationships from sequential precipitation samples.** Raynor, G.S. 1976. Contract EY-76-C-02-0016. 20p. (CONF-761102—3). Dep. NTIS, PC A02/MF A01.

From A.I.M. meeting; Liege, Belgium (15 Nov 1976).

Hourly precipitation samples were collected for chemical analysis with an automatic, sequential sampler. Samples were analyzed for pH, conductivity, sulfate and other constituents. The pH is related to sulfate concentration and atmospheric concentration of small particles. Chemical constituents vary seasonally and with precipitation type. Data permit inferences on the relative importance of rainout and washout.

1360 (BNL—23063) **Development of a technique for measurement of biogenic sulfur emission fluxes.** Hill, F.B.; Barvenik, F.W.; Aneja, V.P.; Felder, R.M. Jul 1977. Contract EY-76-C-02-0016. 52p. (CONF-771102—2). Dep. NTIS, PC A04/MF A01.

From 20. annual AICHE meeting; New York, New York, USA (13 Nov 1977).

Atmospheric sulfur compounds of biogenic origin are thought to constitute a significant fraction of the atmospheric sulfur burden. Determination of fluxes of these compounds into the atmosphere is desirable in order to permit accurate assessment of the relative roles of anthropogenic and biogenic sources in contributing to such phenomena as the atmospheric sulfate burden and acidity in precipitation among others. In the present paper a number of steps in the development of an emission flux measurement technique for biogenic sulfur compounds are described and initial results of use of the technique in a Long Island salt marsh are presented. Experimental fluxes are compared to estimates of biogenic fluxes derived from global sulfur budgets and from a simple mass transfer model. Comparison is also made with anthropogenic emissions expressed as fluxes. Further steps in the development of the technique are suggested.

1361 (BNWL—2100(Pt.1), pp 5-6) **Controlled output aerosol generators.** Cannon, W.C.; Decker, J.R. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical Sciences.

Techniques were investigated for controlling the aerosol generation rates of liquid nebulizers.

1362 (BNWL—2100(Pt.1), pp 9-11) **Sodium aerosol generation.** Allen, M.D.; Kaune, W.T.; Craig, D.K. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical Sciences.

A method has been developed for generating sodium condensation aerosols for rodent inhalation studies. Sodium is vaporized into an argon sweep gas using a resistance furnace. The sodium metal condensate is mixed with air in an aging chamber and is then passed into a rodent exposure chamber.

1363 (BNWL—2100(Pt.1), pp 189-190) **Design and performance of aerosol exposure system.** Gandolfi, A.J.; Hodgson, W.H.; Chandon, J.H. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

An exposure system designed to deliver precise levels of NO/sub x/, SO/sub x/, and CO in combination with a fly ash aerosol is described.

1364 (COO—1248-54) **Electrical charging of small particles at low pressures. Progress report. Particle Technology Laboratory publication number 338.** Liu, B.Y.N.; Whitby, K.T. Jul 1977. Contract EY-76-S-02-1248. 102p. Dep. NTIS, PC A06/MF A01.

Separate abstracts were prepared for three sections of this report that discuss the theory of diffusion charging of aerosol particles, the theory of electrostatic precipitation, and the development of a velocimeter for measuring the aerodynamic size of aerosol particles.

1365 Some approximations for the wet and dry removal of particles and gases from the atmosphere. Slinn, W.G.N. (Battelle Pacific Northwest Labs., Richland, WA). **7**: No. 4, 513-543(Apr 1977).

Semi-empirical formulae are presented which can be used to estimate precipitation scavenging and dry deposition of particles and gases. The precipitation scavenging formulae are appropriate both for in- and below-cloud scavenging and comparisons with data indicate the importance of accounting for aerosol particle growth by water vapor condensation and attachment of the pollutant to plume or cloud particles. It is suggested that both wet and dry removal of gases is usually dictated by other than atmospheric processes. Dry deposition of particles to a canopy is shown to depend on canopy height, biomass, vegetative type and mean wind. Two large-scale practical problems are addressed dealing with the relative importance of wet and dry deposition and with the sources which contribute to deposition in a specific location.

1366 Evidence of high atmospheric concentrations of sulfates detected at rural sites in the northeast. Lioy, P.J. (Interstate Sanitation Commission, New York); Wolff, G.T.; Czachor, J.S.; Coffey, P.E.; Stasiuk, W.N.; Romano, D. **12**: No. 1-2, 1-14(1977).

Ambient sulfates, total suspended particulates (TSP), and ozone data were collected in rural areas of New York and New Jersey as part of a study conducted jointly by the New York State Department of Environmental Conservation and the Interstate Sanitation Commission during July and August 1975. Relationships between these contaminants and various meteorological systems were examined. The sulfate and TSP data were obtained from 24-hour integrated high volume samples obtained on a daily basis at seven rural sites with the emphasis in this paper being on two sites: Whiteface Mountain, N.Y., and High Point, N.J. The sulfate concentrations were found to be highest during four distinct periods which were generally defined by anticyclonic stagnation and/or return flow of maritime tropical air. The highest values recorded at Whiteface Mountain and High Point were 24 $\mu g/m^3$ and 20 $\mu g/m^3$, respectively, in the period from July 21 through 25. During the other three periods, a maximum of at least 15 $\mu g/m^3$ was observed at one or both sites. Coincidence of the high level periods at the two sites separated by approximately 200 miles and at five other rural New York State sites during most of the study is a strong indication of long-range transport. The maximum sulfate concentration recorded during the study was 38 $\mu g/m^3$ at Schoharie, N.Y. The SO_4/TSP ratio (maximum 0.53) at High Point and Whiteface Mountain was increased, though nonuniformily, with higher TSP during the episode periods. Ozone concentrations at High Point were increased simultaneously with sulfates, as in previous observations at Whiteface Mountain which suggests it is either an important reactant in the formation of sulfates or these contaminants are concommitant in photochemical processes and/or summertime anticyclonic systems.

1367 (PB—266974-T/SL) **Air conservation. Volume 8, Number 6(44), 1974.** Translated from 8: No. 6, vp(1976). 76p. (TT—74-54053/6). NTIS PC A05/MF A01.

Contents: Kinetics of sulfur dioxide absorption in calcium carbonate aqueous suspension, Dust control, Method of distributing SO_2 concentration measuring points over the city area, and Studies on the application of aluminum oxides for hydrogen fluoride adsorption.

1368 **Systematic approach for minimizing the costs of air pollution control.** Lancour, J.B. (Univ. of Toledo). pp 651-656 of In Modeling and simulation. Volume 7, Part 1. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P1.

Industry is in dire need of an effective approach for minimizing the costs of air pollution. This need arises from the requirement of industry to comply with emission and/or ambient air-quality standards. In this approach, the problem areas are identified and defined. For those areas that require control, the costs associated with owning, operating, and maintaining several levels of control for various control alternatives are projected over a ten-year period. Each cash flow is adjusted to account for taxes, depreciation, interest, and timing. From these data zero-one integer programming techniques and an optimization algorithm are used to define that combination of controls that minimizes the cost of complying with emission and ambient air-quality controls.

1369 **Air-quality impact from electric generation.** Shimamoto, G.T. (Univ. of Pennsylvania, Philadelphia); Cadogan, J.B.; Eisenberg, L. pp 974-979 of In Modeling and simulation. Volume 7, Part 2. Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976).

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

See CONF-760435—P2.

Environmental dispatch, an application of intermittent control to electric utility systems, is described within the context of alternative pollution control strategies. The effects of system dispatch under economic and environmental criteria upon operating costs, SO_2 emission rates and ambient air quality are illustrated by dispatch simulation of an Eastern utility system and dispersion modeling of each unit's emissions.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

1370 (BNL—22627) **1976 environmental monitoring report.** Naidu, J.R. (comp.). Apr 1977. Contract EY-76-C-02-0016. 90p. Dep. NTIS, PC A05/MF A01.

The environmental levels of radioactivity and other environmental pollutants found in the vicinity of Brookhaven National Laboratory during 1976 are summarized. As an aid in the interpretation of the data, the amounts of radioactivity and other pollutants released in airborne and liquid effluents from Laboratory facilities to the environment are also indicated. The environmental data includes external radiation levels; radioactive air particulates; tritium and iodine concentrations; the amounts and concentrations of radioactivity in precipitation; the amounts and concentrations of radioactivity in and the quality of the stream into which liquid effluents are released; the concentrations of radioactivity in sediments and biota from the stream; the concentrations of radioactivity in and the quality of ground waters underlying the Laboratory; and concentrations of radioactivity in milk, grass, and soil samples obtained in the vicinity of the Laboratory. The external radiation level for 1976 at the north boundary of the Laboratory attributable to an ecology forest irradiation source was 74.4 mrem, or 14 percent of the applicable Radiation Protection Standard.

1371 (BNWL—2100(Pt.1), pp 12-13) **Laser-generated PuO_2—UO_2 condensation aerosols.** Allen, M.D.; Kaune, W.T.; Craig, D.K. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical Sciences.

A 340-watt CO_2 laser is being used to generate PuO_2-UO_2 condensation aerosol from the surface of a Liquid Metal Fast Breeder Reactor (LMFBR) fuel pellet. A wide range of concentrations is achieved by varying the laser power, pulse width, and/or pulse period. The resulting aerosol is composed of branch chain-like aggregates, with the primary particle size ranging between 0.005 and 0.15 μm. X-ray diffraction analyses show that these aerosols condense into a face-centered cubic crystal structure. The activity mean aerodynamic diameter (AMAD), for most power levels, is approximately 0.85 μm with a geometric standard deviation of 1.5.

1372 (COO—323-38) **Measurement of atmospheric alpha activity.** Spokas, J.J. 1977. Contract EY-76-S-02-0323. 22p. (CONF-770591—1). Dep. NTIS, PC A02/MF A01.

From Joint scientific meeting; Lake Geneva, Wisconsin, USA (7 May 1977).

Results of two studies, one based on daily measurements over a period of approximately 5.5 weeks and the other measurements over a period of 62 days led to the conclusion that the ground-level atmospheric alpha activity is subject to variations of at least an order of magnitude. Possibly significant correlations were found between atmospheric alpha activity and temperature and humidity. The activity in stagnant air may be one to two orders of magnitude greater than the average found outdoors. Radon-222 and its daughters would seem to account essentially for the entire α activity in the atmosphere. The atmospheric alpha activity was measured absolutely with an ionization chamber coupled to a sensitive electrometer.

1373 (ERDA—77-101) **Radiation protection enrollments and degrees, 1976.** Aug 1977. Contract EY-76-C-05-0033. 48p. Dep. NTIS, PC A03/MF A01.

This is a report on the sixth annual survey of radiation protection enrollments and degrees of 52 US institutions that reported degrees and enrollments during 1976. The survey is sent to institutions offering educational programs in radiation protection (health physics, radiation health and safety, radiological health, and similar programs), graduates of which would be qualified to be responsible for some major phase of a program for the evaluation and control of radiation hazards.

1374 (HASL—327) **System for continuous radon determination.** Thomas, J.W. Jul 1977. 16p. Dep. NTIS, PC A02/MF A01.

A system for continuous radon determination in air samples based on alpha counting has been developed which takes into consideration deposition of radon daughters in the radon detecting volume. The radon concentration is calculated from the total number of alpha counts obtained in successve 2000s time intervals, the detector volume and counting efficiency, and an experimentally determined radon daughter deposition factor.

1375 (ORO—3944-14) **Atmospheric HT and HTO, 1975—1976. Tritium Laboratory data report No. 7.** Mason, A.S.; Oestlund, H.G. Jul 1977. Contract EY-76-S-05-3944. 55p. Dep. NTIS, PC A04/MF A01.

Results are reported from regular, twice or three times weekly, sampling of atmospheric HTO and HT at stations in Miami, FL; Mauna Loa, HI; Fairbanks, AK; and Baring Head, N.Z. In addition, sampling has begun in Miami also for tritium bound in lower hydrocarbons, here called CH_3T. During the two-year period, Jan 1975-Dec 1976, there has been no measurable trend in HTO at these stations. Neither the underground nor the atmospheric nuclear testing has affected the yearly average HTO levels on the global scale to a measurable extent. The HT data for the same time indicates a slight long-term decrease in the northern hemisphere from around 53 at/mg air in 1974 to 50 at/mg in 1976. The southern hemisphere has a slightly lower average of 40 at/mg in 1976. These numbers are equivalent to a global atmospheric inventory of 1.2 kg of tritium bound as hydrogen gas in 1976. Temporary peaks appear after certain very large underground tests, and as results of large spills of tritium gas. Total amount of tritium in hydrocarbons is 5 +- 1 at of T/mg of air with rather large scatter.

1376 (RFP-ENV—76) **Annual environmental monitoring report, January—December 1976.** 6 May 1977. Contract EY-76-C-04-3533. 44p. Dep. NTIS, PC A05/MF A01.

Data are presented from the environmental monitoring program at Rocky Flats Plant during 1976. Data are included on the radioactivity in air samples, the content of Pu, Am, U, and tritium in water samples, and Pu in soil samples from various locations. Chemical and biological constituents in sewage treatment plant effluents are reported. The public radiation dose was approximately 0.11 millirem/yr at the Plant perimeter.

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 974

REGULATIONS

REFER ALSO TO CITATION(S) 972

ENVIRONMENTAL SCIENCES, TERRESTRIAL

REFER ALSO TO CITATION(S) 1355, 1414

BASIC STUDIES

1377 (CONF-770730—1) **Transmutations across hierarchical levels.** O'Neill, R.V. 1977. Contract W-7405-ENG-26. 26p. Dep. NTIS, PC A03/MF A01.

From Symposium on statistical ecology; College Station, Texas, USA (25 Jul 1977).

The development of large-scale ecological models depends implicitly on a concept known as hierarchy theory which views biological systems in a series of hierarchical levels (i.e., organism, population, trophic level, ecosystem). The theory states that an explanation of a biological phenomenon is provided when it is shown to be the consequence of the activities of the system's components, which are themselves systems in the next lower level of the hierarchy. Thus, the behavior of a population is explained by the behavior of the organisms in the population. The initial step in any modeling project is, therefore, to identify the system components and the interactions between them. A series of examples of transmutations in aquatic and terrestrial ecosystems are presented to show how and why changes occur. The types of changes are summarized and possible implications of transmutation for hierarchy theory, for the modeler, and for the ecological theoretician are discussed.

1378 (TID—27758) **Movement and dispersal patterns of immature gray squirrels (Sciurus carolinesis) in east-central Minnesota.** Gull, J. Mar 1977. Contract EY-76-S-02-1332. 121p. Dep. NTIS, PC A06/MF A01.

Thesis.

Movements of immature gray squirrels and their mothers were monitored via an automatic radio tracking system in east-central Minnesota from the time of the juveniles' emergence until their dispersal. Eleven juveniles and three adult females were observed. Examination of home range dynamics revealed that juvenile range size increased from 0.45 ha in early summer to 4.00 ha in late summer. Range shrinkage occurred in late fall.

1379 (UCLA—12-1123) **Challenge of a desert: revegetation of disturbed desert lands.** Wallace, A.; Romney, E.M.; Hunter, R.B. 1977. Contract EY-76-C-03-0012. 23p. (CONF-770369—1). Dep. NTIS, PC A02/MF A01.

From NAEG Pu program report meeting; Las Vegas, Nevada, USA (2 Mar 1977).

The revegetation of disturbed, arid lands is one of the great challenges of a desert. It is not an impossible task, however, if one utilizes and properly manages both the natural and the man-made resources available. Through better understanding of the processes governing revegetation and the ability to control them, it is possible for man to more rapidly restore disturbed desert lands. Terrain manipulation to form moisture catchment basins, selection of seed from pioneering shrub species, preservation of existing shrub clump fertile islands in the soil, supplemental fertilization and irrigation, and transplanting vigorous shrub species are some of the important things that can be done to help restore disturbed desert land. Some of the costs can be off-set by restoring the land to economically important trees and shrubs, or grasses, instead of back to the original vegetation. Thousands of years of historical evidence of man's survival on arid lands attest to success in meeting the challenge of the desert. (41 references)

1380 (US/IBP—77/1(Vol.4)) **Abstracts: US-International Biological Program ecosystem analysis studies. Volume IV, No. 4.** Watts, J.A.; Johnson, M.L. (eds.). Jul 1977. Contract W-7405-ENG-26. 238p. Dep. NTIS, PC A11/MF A01.

Abstracts and indexes are included for some 700 references to publications that discuss coniferous forest biomes, the Eastern deciduous forest biome, desert biomes, and tundra biomes.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 1443, 1531, 1533

1381 Acidity of open and intercepted precipitation in forests and effects on forest soils in Alberta, Canada. Baker, J.; Hocking, D.; Nyborg, M. (Univ. of Alberta, Edmonton). 7: No. 4, 449-460(Apr 1977).

Emissions of SO_2 appear to have an acidifying effect on grossfall (open rainfall), throughfall, stemflow and soil solution at sites near major sources. Resulting effects on soil chemistry include elevated extractable acidity and aluminum and depressed exchangeable bases, especially Ca and Mg. These changes are mostly in the incipient phases in the study area.

1382 Effect of sulfur dioxide on precipitation and on the sulfur content and acidity of soils in Alberta, Canada. Nyborg, M. (Univ. of Alberta, Edmonton); Crepin, J.; Hocking, D.; Baker, J. 7: No. 4, 439-448(Apr 1977).

Rain and snow in Alberta are seldom acid. The S content of snow is so low that the snow pack gives a deposition of less than 1 kg S ha^{-1}, even downwind from large SO_2 emission sources. Rainfall contributes at the most 4 kg S ha^{-1} yearly near SO_2 sources, and only about 1 kg S ha^{-1} in clean areas. However, rain intercepted by forest trees exposed to SO_2 emission becomes acid (pH 3.5 to 4.5) and has a S content of 3 to 4 times greater than rain. Soils absorb large amounts of S from emissions (up to 50 kg S ha^{-1} annually) but much of the S is found in non-sulphate form. Soils are slowly acidified by the SO_2 at a rate estimated at 1 pH unit in 10 to 20 yr. Water surfaces will absorb SO_2 emissions at a rate of about 4 to 15 kg S ha^{-1} annually. Particulates deposit 3 to 4 times as much S as is deposited by rainfall.

1383 Sulfate mobility in an outwash soil in western Washington. Johnson, D.W.; Cole, D.W. (Univ. of Washington, Seattle). 7: No. 4, 489-495(Apr 1977).

The effect of acidic precipitation on cation leaching in a second-growth Douglas-fir ecosystem at the Thompson Research Center is reviewed. Sulfate mobility and soil pH buffering power were tested by applications of heavy doses of H_2SO_4 to the study plot. Sulfate at high concentrations proved to be immobilized, presumably by adsorption to soil sesquioxide surfaces. Soil sulfate adsorption was determined at varying sulfate concentrations, and two mechanisms of adsorption are implied by the shapes of the isotherms.

1384 Soil acidification by atmospheric pollution and forest growth. Jonsson, B. (Royal Coll. of Forestry, Stockholm). 7: No. 4, 497-501(Apr 1977).

In recent years concern has been expressed about the danger of harmful pollution deposits which affect areas at great distances from the emission sources. The investigation was so designed that a possible reaction in growth resulting from a supposed acidification could be observed as far as possible. A poorer growth development was observed in regions, which are suspected of being more susceptible to acidification than those regions which are presumed to be less susceptible in this respect. We have found no good reason for attributing the reduction in growth to any cause other than acidification.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 1373, 1376, 1411, 1412, 1413

SOIL

1385 (ORNL-tr—4425) **Distribution coefficient k/sub d/ of radionuclide between sample soil and water.** Inoue, Y.; Morisawa, S. Translated by T.E. Ohtani from **18**: No. 8, 524-534(1976). 24p. Dep. NTIS, PC A02/MF A01.

Distribution coefficients between sample soil and water were determined for 17 soil samples and 9 radionuclides by batch and/or column method. Those experimental data were analyzed on some environmental factors, such as macro ionic component in liquid phase, percolation rate of water through soil column, saturation degree of the soil pore with water, cation exchange capacity of soil and so on, which might have large influence on a variation of K/ub d/. Some instructive results were obtained such as: relative magnitude of k/sub d/ for ^{90}Sr, ^{137}Cs and ^{60}Co does not depend on the sample soil. K/sub dCa/ is the largest among 3 nuclides and is followed by k/sub dCo/. K/sub dSr/ is the smallest; k/sub d/ for calcium rich soil might be estimated mainly based on Ca + Mg concentration in water phase, and k/sub d/ for calcium poor soil based on pH in water phase; positive correlation is observed between k/sub d/ of ^{90}Sr and cation exchange capacity of soil; k/sub d/ for unsaturated soil with water are observed to be larger than k/sub d/ determined for saturated soil with water; and ^{90}Y, /sup 110m/Ag and ^{59}Fe among 9 nuclides used in this work might be stable in non-ionic form in water.

TERRESTRIAL ECOSYSTEMS AND FOOD CHAINS

REFER ALSO TO CITATION(S) 325, 1370, 1411, 1412, 1413

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 406, 987, 1411, 1412, 1413

1386 (ARH-LD—127) **Geology of the 241-A Tank Farm.** Price, W.H.; Fecht, K.R. Apr 1976. Contract EY-76-C-06-2130. 55p. Dep. NTIS, PC A04/MF A01.

A series of maps have been compiled to document the structure and stratigraphy of the sediments underlying the high-level radioactive waste storage tank farms located within the Energy Research and Development Administration Hanford Reservation. The primary purpose of these maps is to provide basic geologic information to be utilized to evaluate the impact of suspected and confirmed tank leaks. The contents of this packet contain maps compiled only for the 241-A Tank Farm.

1387 (ARH-LD—128) **Geology of the 241-AX Tank Farm.** Price, W.H.; Fecht, K.R. Apr 1976. Contract EY-76-S-06-2130. 51p. Dep. NTIS, PC A04/MF A01.

A series of maps have been compiled to document the structure and stratigraphy of the sediments underlying the high-level radioactive waste storage tank farms located within the Energy Research and Development Administration Hanford Reservation. The primary purpose of these maps is to provide basic geologic information to be utilized to evaluate the impact of suspected and confirmed tank leaks. The contents of this packet contain maps compiled only for the 241-AX Tank Farm.

1388 (ARH-LD—129) **Geology of the 241-B Tank Farm.** Price, W.H.; Fecht, K.R. Apr 1976. Contract EY-76-C-06-2130. 63p. Dep. NTIS, PC A04/MF A01.

A series of maps have been compiled to document the structure and stratigraphy of the sediments underlying the high-level radioactive waste storage tank farms located within the Energy Research and Development Administration Hanford Reservation. The primary purpose of these maps is to provide basic geologic information to be utilized to evaluate the impact of suspected and confirmed tank leaks. The contents of this packet contain maps compiled only for the 241-B Tank Farm.

1389 (ARH-LD—130) **Geology of the 241-BX Tank Farm.** Price, W.H.; Fecht, K.R. Apr 1976. Contract EY-76-C-06-2130. 63p. Dep. NTIS, PC A04/MF A01.

A series of maps have been compiled to document the structure and stratigraphy of the sediments underlying the high-level radioactive waste storage tank farms located within the Energy Research and Development Administration Hanford Reservation. The primary purpose of these maps is to provide basic geologic information to be utilized to evaluate the impact of suspected and confirmed tank leaks. The contents of this packet contain maps compiled only for the 241-BX Tank Farm.

1390 (ARH-LD—131) **Geology of the 241-BY Tank Farm.** Price, W.H.; Fecht, K.R. Apr 1976. Contract EY-76-C-06-2130. 44p. Dep. NTIS, PC A03/MF A01.

A series of maps have been compiled to document the structure and stratigraphy of the sediments underlying the high-level radioactive waste storage tank farms located within the Energy Research and Development Administration Hanford Reservation. The primary purpose of these maps is to provide basic geologic information to be utilized and to evaluate the impact of suspected and confirmed tank leaks. The contents of this packet contain maps compiled only for the 241-BY Tank Farm.

REGULATIONS

REFER ALSO TO CITATION(S) 110

ENVIRONMENTAL SCIENCES, AQUATIC

REFER ALSO TO CITATION(S) 1355, 1414

BASIC STUDIES

REFER ALSO TO CITATION(S) 1377, 1522, 1537

1391 (ORNL-tr—4400) **Modes of dispersal and types of development of the fresh water bivalve molluscs (bivalvia).** Gilyarov, M.S. Translated by S.D. Blalock Jr. from **49**: No. 4, 621-633(1970). 17p. Dep. NTIS, PC A02/MF A01.

Most of the marine pelecypods are characterized by passive migration of plankton trochophore larvae. The switch to life in rivers rules out the possibility of such dispersal and the plankton larvae drift in the sea. Dispersal is passive in the fresh water forms but phoresia and not hydrochory plays a leading role in it. A diagram is given in which the correlation between the type of dispersal, the type of development and the character of the larva is reflected.

1392 (ORNL-tr—4401) **Korean Corbicula (study on east Asian Corbicula family-2).** Oyama, K. Translated by T. Ohtani from **12**: No. 3-4, 150-158(1943). 9p. Dep. NTIS, PC A02/MF A01.

Seven species of Korean bivalve molluscs of the genus Corbicula are listed. Data are presented for each species on morphology, habitat, and distribution. (HLW)

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 1198, 1370, 1376

1393 (COO—1599-125(Pt.1)) **Dissolved organic matter and lake metabolism. Technical progress report, 1 July 1976—30 June 1977.** Wetzel, R.G. 1977. Contract EY-76-S-02-1599. 61p. Dep. NTIS, PC A04/MF A01.

Progress is reported on investigations on the qualitative and quantitative cycling of particulate and dissolved organic matter within lakes and their drainage basins. Interactions of dissolved organic matter with inorganic nutrient cycling and regulation of the photosynthetic and decompositional metabolism of micro- and macroflora remain the focal point of these studies. Major efforts were directed towards the sources fates, pathways, and interactions of dissolved organic matter in inorganic chemical cycling; allochthonous sources, metabolism en route, and inputs to the lake systems of increasing stages of eutrophication; and the relationships of these compounds to the nutrient physiology and metabolism of phytoplankton, sessile algae, macrophytes, and bacterial populations. Results of studies carried out in a freshwater lake in Michigan (Lawrence Lake) are reported. 165 references.

1394 (COO—3390-28) **Accumulation and transport of minerals by marine protozoa. Progress report, September 1, 1976—November 30, 1977.** Gold, K. Aug 1977. Contract EY-76-S-02-3390. 12p. Dep. NTIS, PC A02/MF A01.

Tintinnida are abundant microzooplankton found in all of the world's oceans, and important components of the marine food web as predators, prey, and as regenerators of nutrients. The agglutinated forms take on added importance in coastal waters. Representatives of this group have the unique ability among ciliates to pick up particles from the environment and incorporate them into the lorica. The ecological significance of the phenomenon lies in: it is a pathway whereby radionuclides, metals and other toxic substance can be biologically concentrated and transferred from sediments and the water column to the biota; from the viewpoint of microzooplankton as indicators of environmental perturbations, pollution, or water mass movements, it is important to determine whether minerals accumulated on the lorica can serve as a guide to the site where they originate. Results are reported from studies in progress on the types of mineral matter accumulated by tintinnids.

1395 **Chemical and biological relationships relevant to the effect of acid rainfall on the soil-plant system.** Reuss, J.O. (Environmental Protection Agency, Corvallis, OR). 7: No. 4, 461-478(Apr 1977).

The paper deals with problems concerning measurements of rainfall acidity and interpretation in terms of possible effects on the soil-plant system. The theory of acidity relationships of the carbon dioxide-bicarbonate equilibria and its effect on rainfall acidity measurements is given. The relationship of a cation-anion balance model of acidity in rainfall to plant nutrient uptake processes is discussed, along with the relationship of this model to a rainfall acidity model previously proposed in the literature. These considerations lead to the conclusion that average H^+ concentration calculated from pH measurements is not a satisfactory method of determining H^+ loading from rainfall if the rain is not consistently acid. Calculating loading from H^+ minus HCO_3^-, strong acid anions minus basic cations, or net titratable acidity is suggested. The flux of H^+ ions in soil systems due to plant uptake processes and sulfur and nitrogen cycling is considered. H^+ is produced by oxidation of reduced sulfur and nitrogen compounds mineralized during decomposition of organic matter. Plant uptake processes may result in production of either H^+ or OH^- ions. Fluxes of H^+ from these processes are much greater than rainfall H^+ inputs, complicating measurement and interpretation of rainfall effects. The soil acidifying potential due to the oxidation of the NH_4^+ rainfall is examined, with the conclusion that acidity from this source is of a similar magnitude to direct H^+ inputs common in rainfall.

1396 Hydrocarbons in eastern Canadian marine waters determined by fluorescence spectroscopy and gas—liquid chromatography. Keizer, P.D.; Gordon, D.C. Jr.; Dale, J. (Bedford Inst. of Oceanography, Dartmouth, N.S.). **34**: No. 3, 347-353(Mar 1977).

Concentrations of n-alkanes ranged from < 20 ng/l to about 1 μg/l at depths of 2 and 50 m. Estimated oil concentrations based on fluorescence analyses ranged from 0.2 to 9.3 μg/l. The highest concentrations occurred in Bedford Basin; the similarity of fluorescence contour plots to petroleum products and the presence of unresolved envelopes in chromatograms suggest that a large portion of the hydrocarbons in the Basin are derived from oil. Hydrocarbons in other regions appear to be principally biogenic in origin.

1397 Manganese cycling in the Newport River estuary, North Carolina. Evans, D.W. (Oregon State Univ., Corvallis); Cutshall, N.H.; Cross, F.A.; Wolfe, D.A. **5**: No. 1, 71-80(Jan 1977).

Dissolved Mn was measured in the Newport River estuary, North Carolina, in October 1974, February 1975 and April 1975 by extraction on Chelex-100 resin and subsequent analysis of flameless atomic absorption spectrophotometry. Dissolved Mn concentrations at intermediate salinities were in excess of those predicted by conservative mixing of inflowing river and ocean water, with maxima between 4 and 14% salinity. Reduction and solubilization of Mn in bottom sediments in the upper estuary probably supplies much of the added dissolved Mn. Fixation of dissolved Mn on particles takes place in the lower estuary with subsequent upstream recycling. The export of dissolved Mn from the estuary in excess of that input by the river is probably balanced by continuous traction flows of river-derived bed sediment or pulse inputs of suspended sediment in storm runoff followed by partial solubilization.

1398 Suggested method for vanadate removal from mill effluents. Michalovic, J.G.; Fisher, J.G.; Bock, D.H. **12**: No. 1-2, 21-27(1977).

The removal of vanadium, as vanadate ion, from waste streams is described. A series of experiments was devised to study the process of vanadium removal by precipitation in the presence of excess ferric hydroxide which yields vanadate concentrations of less than 4 mg/l consistently. Under most initial concentration and pH conditions vanadium can be removed to less than 5 mg/l in the laboratory in essentially pure water and with careful control. The similarity of pH, vanadium, and iron concentrations in the pond and pond seepage situations to those in the experiment suggest that high dissolved solid concentrations do not seriously interfere with the process described. To be certain that vanadium removal can be accomplished in other waste water streams, further pilot plant treatment studies should be performed. (CAJ)

1399 Mercury in catfish and bass from the Snake River in Idaho. Benson, W.W.; Webb, W.; Brock D.W.; Gabica, J. (Dept. of Health and Welfare, Boise, ID). **15**: No. 5, 564-567(May 1976).

Monitoring was undertaken to determine differences between fish taken in impoundment areas and, at the same time, determine whether mercury levels increased with age of the fish. Results of the study corroborate the findings of other investigators in the case of bass alone; not so with the catfish studied. With the bass, for example, there was an increase in mercury concentration from 0.59 ppm to 0.72 ppm between the ages of two and four years in the impounded waters and from 0.67 ppm to 1.15 ppm for the same age period in the free flowing waters. Also there was a small increase in the mean values of from 0.65 to 0.79 ppm between the former to the latter group. This condition was not apparent, however, in the case of catfish, where both patterns with respect to age and habitat, if anything, seemed to be reversed. In all cases, however, except for catfish in the free flowing waters, the mean levels for mercury concentration set by the F.D.A. (0.50 ppm) was exceeded. On this basis, these results would seem to be of some concern to anglers.

1400 Mercury content in several species of marine fish. Cugurra, F.; Maura, G. (Univ. Inst. of Pharmacology, Genova). **15**: No. 5, 568-573(May 1976).

A survey was conducted for determining the total mercury content in fish available on the market or fished in the port of Genoa (Italy). Tinned tuna, anchovies, sardines and mackerel, as well as frozen umbrina and dried cod fish were bought on the market. Fresh fish, sardines and oculata were fished in the port. Total mercury content was determined by flameless atomic absorption. Results showed higher amounts in the fresh fish than in tinned, with both having higher levels than fish from non-polluted areas. Fish taken from polluted waters is the main source of mercury poisoning for man. (CAJ)

1401 Carbon monoxide concentrations in surface waters of the east tropical Pacific in 1974: comparison with earlier values. Swinnerton, J.W.; Lamontagne, R.A.; Smith, W.D. (Naval Research Lab., Washington, DC). **4**: No. 1, 57-65(Mar 1976).

Concentrations of carbon monoxide were measured in the surface waters of the east tropical Pacific during a cruise aboard USNS "Hayes" from Ecuador to Panama via Hawaii and Tahiti in the late winter and early spring of 1974. Data comparisons were made for time spans of 1.3 to 3.7 years at several locations where the cruise track intersected or closely paralleled portions of our two earlier Pacific cruise tracks. The comparisons showed remarkable consistency, considering the range of variability of carbon monoxide concentration. Latitudinal variations of concentrations found during the earlier cruises were reconfirmed.

1402 Distribution of total Al, Cd, Co, Ni, and Zn in the tongue of the ocean and the northwestern Atlantic Ocean. Alberts, J.J.; Leyden, D.E.; Patterson, T.A. (Univ. of Georgia, Athens). **4**: No. 1, 51-56(Mar 1976).

The elements Al, Cd, Co, Cu, Ni, and Zn were concentrated from seawater using tetraethylenepentamine resin and analyzed by atomic absorption spectrophotometry. The spatial distribution of these elements in the northwest Atlantic Ocean is discussed with respect to possible riverine inputs to the area from Puerto Rico.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 1370, 1373, 1376

1403 (BNWL—2228) **Mathematical simulation of sediment and radionuclide transport in the Columbia River.** Onishi, Y. Aug 1977. Contract EY-76-C-06-1830. 113p. Dep. NTIS, PC A06/MF A01.

Mathematical simulation of radionuclide transport was conducted by applying the finite element sediment and contaminant transport model, SERATRA, to the Columbia River between the Priest Rapids and McNary Dams near the ERDA Hanford Reservation. Model computations were performed to solve time-dependent, longitudinal and vertical distributions of sediments and radionuclides by taking into account sediment-radionuclide interaction. Sediment transport was modeled for three sediment size fractions (i.e., sand, silt, and clay), and radionuclide transport was simulated for dissolved and particulate nuclides. Particulate radionuclides were analyzed for those adsorbed by sediment in each sediment size fraction. Five cases were simulated in this study to identify the effects of river sediments on radionuclide migration: continuous release of ^{65}Zn without adsorption mechanics; continuous release of ^{65}Zn with adsorption; instantaneous release of ^{65}Zn without adsorption; instantaneous release of ^{65}Zn with adsorption; and radionuclide resuspension. Sediment and radionuclide results indicate very good agreement with measured data.

1404 (BNWL—2305) **Association of Hanford origin radionuclides with Columbia River sediment.** Robertson, D.E.; Fix, J.J. Aug 1977. Contract EY-76-C-06-1830. 102p. Dep. NTIS, PC A06/MF A01.

Results are reported from measurements of present radionuclide concentrations in Columbia River sediments. A description of the rates and mechanisms governing the decrease in radioactivity levels in the river sediments between 1971 and 1976; a characterization of the areal and depth distribution of fine grain, silty sediments in the McNary Reservoir mode by sub-bottom seismic surveying; and analysis of deep piston cores which penetrate the entire thickness of sediment deposits at selected sites in McNary Reservoir to provide radionuclide data for estimating the inventories of radionuclides in the sediment deposits in the McNary Reservoir are included. The results of these studies showed that the short- and intermediate-lived radionuclides have now decayed to insignificant levels, and only a few long-lived radionuclides (i.e., ^{54}Mn, ^{55}Fe, ^{60}Co, ^{137}Cs, $^{152-154}Eu$, ^{238}Pu, $^{239-240}Pu$, and ^{241}Am) at trace concentrations remain buried in the sediment deposits. The surface sediments in the McNary Reservoir contain much lower radionuclide concentrations than deeper sediments because of the build-up of 40 to 80 cm of fresh, relatively uncontaminated new sediment deposits since 1971.

WATER

1405 (AD-A—039749) **A gamma-ray counting apparatus for evaluating the fallout removal effectiveness of reverse-osmosis water purification systems. Memorandum report Feb 1976—Feb 1977.** Thomson, G.; Schiller, S.; Goshorn, J.; Kaufman, E.; Hollandsworth, C. May 1977. 22p. (BRL-MR—2746). NTIS PC A02/MF A01.

A gamma ray detection system and the procedures for its calibration and use are described. This system was employed during a joint Ballistic Research Laboratory - Mobility Equipment R and D Center test of a reverse-osmosis water purification system's ability to remove dissolved radioisotopes, i.e. fallout, from drinking water. The detector system is able to dose count water samples in the range of activities from a few tens to a few millions of picocuries per liter in a time period of thirty minutes. Its design is based upon scintillation methods and emphasizes counting efficiency, calibration accuracy, and a minimum of sample preparation. In tests on over four

hundred samples using the system the activity attenuation of streams of water following reverse-osmosis processing was measured with error of a fraction of one percent. The accuracy of absolute dose level determinations was limited by the errors in the calibration standards at the highest levels and by counting statistics at the lowest levels.

1406 (PB—266950) **Costs of radium removal from potable water supplies. Final report.** Singley, J.E.; Beaudet, B.A.; Bolch, W.E.; Palmer, J.F. Apr 1977. 153p. NTIS PC A08/MF A01.

This report presents the results of an analysis of existing data from various sources on the removal of radium from potable water supplies by lime-soda softening, ion exchange, and reverse osmosis treatment methods. Removal efficiency models are used to estimate the capital and annual operating and maintenance costs for each water treatment process over a wide range of raw water quality, raw water radium, and population conditions. The radiological consequences of common methods of waste sludge and brine disposal are discussed and waste volumes and activity levels of radium in waste streams are estimated. The costs of ultimate disposal of the waste streams produced by each process are estimated over the same raw water quality and population ranges used to determine treatment costs. This report is intended as a guide for planners and water utility personnel in areas where the radium activity of potable water sources exceeds the limits set by EPA Drinking Water Regulations.

THERMAL EFFLUENTS MONITORING AND TRANSPORT

1407 (ORNL/TM—5877/V1) **Selective analysis of power plant operation on the Hudson River with emphasis on the Bowline Point Generating Station. Volume 1.** Barnthouse, L.W.; Cannon, J.B.; Christensen, S.G. Jul 1977. Contract W-7405-ENG-26. vp. Dep. NTIS, PC A99/MF A01.

A comprehensive study of the effects of power plant operation on the Hudson River was conducted. The study included thermal, biological, and air quality effects of existing and planned electrical generating stations. This section on thermal impacts presents a comprehensive mathematical modeling and computer simulation study of the effects of heat rejection from the plants. The overall study consisted of three major parts: near-field analysis; far-field analysis; and zone-matched near-field/far-field analysis. Near-field analyses were completed for Roseton, Danskammer, and Bowline Point Generating Stations, and near-field dilution ratios range from a low of about 2 for Bowline Point and 3 for Roseton to a maximum of 6 for both plants. The far-field analysis included a critical review of existing studies and a parametric review of operating plants. The maximum thermal load case, based on hypothetical 1974 river conditions, gives the daily maximum cross-section-averaged and 2-mile-segment-averaged water temperatures as 83.80°F in the vicinity of the Indian Point Station and 83.25°F in the vicinity of the Bowline Station. This maximum case will be significantly modified if cooling towers are used at certain units. A full analysis and discussion of these cases is presented. A study of the Hudson River striped bass population is divided into the following eight subsections: distribution of striped bass eggs, larvae, and juveniles in the Hudson River; entrainment mortality factor; intake factor; impingement; effects of discharges; compensation; model estimates of percent reduction; and Hudson River striped bass stock.

1408 (ORNL/TM—5877/V2) **Selective analysis of power plant operation on the Hudson River with emphasis on the Bowline Point Generating Station. Volume 2.** Barnthouse, L.W.; Cannon, J.B.; Christensen, S.G. Jul 1977. Contract W-7405-ENG-26. vp. Dep. NTIS, PC A15/MF A04.

Because of the location of the Bowline, Roseton, and Indian Point power generating facilities in the low-salinity zone of the Hudson estuary, operation of these plants with the present once-through cooling systems will adversely influence the fish populations that use the area for spawning and initial periods of growth and development. Recruitment rates and standing crops of several fish species may be lowered in response to the increased mortality caused by entrainment of nonscreenable eggs and larvae and by impingement of screenable young of the year. Entrainment and impingement data are particularly relevant for assessing which fish species have the greatest potential for being adversely affected by operation of Bowline, Roseton, and Indian Point with once-through cooling. These data from each of these three plants suggest that the six species that merit the greatest consideration are striped bass, white perch, tomcod, alewife, blueback herring, and bay anchovy. Two points of view are available for assessing the relative importance of the fish species in the Hudson River. From the fisheries point of view, the only two species of major importance are striped bass and shad. From the fish-community and ecosystem point of view, the dominant species, as determined by seasonal and regional standing crops (in numbers and biomass per hectare), are the six species most commonly entrained and impinged, namely, striped bass, white perch, tomcod, alewife, blueback herring, and anchovy.

1409 **Susceptibility of threadfin shad to impingement.** Griffith, J.S.; Tomljanovich, D.A. pp 223-234 of In Proceedings of the 29th annual conference of the Southeastern Association of Game and Fish Commissioners. Frankfort, KY; Southeastern Association of Game and Fish Commissioners (1975).

From 29. annual conference of the Southeastern Association of Game and Fish Commissioners; St. Louis, MO, USA (13 Oct 1975).

Threadfin shad impingement at 13 Tennessee Valley Authority electric generating plants from August 1974 through July 1975 was analyzed to assess mortality resulting from low water temperature. Concurrent laboratory experiments were conducted to evaluate the ability of cold-stressed thread-fin shad to avoid impingement. Temperatures of 12°C stressed fish in the laboratory, while those below 8°C caused high impingement mortality. At 5 of 12 fossil-fuel plants, 90 percent or more of the annual threadfin impingement occurred when water temperatures were below 10°C. At four plants, impingement was not related to low temperatures. Impingement at the Browns Ferry Nuclear Plant generally coincided with low water temperatures, but individual impingement peaks were not consistently associated with cold shocks.

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 976

ENVIRONMENTAL-SOCIAL ASPECTS OF ENERGY TECHNOLOGIES

SOCIAL AND ECONOMIC STUDIES

REFER ALSO TO CITATION(S) 960, 976, 993, 1009

ASSESSMENT OF ENERGY TECHNOLOGIES

REFER ALSO TO CITATION(S) 970

1410 (NUREG—0201) **Improving regulatory effectiveness in federal/state siting actions: water supplies and the nuclear licensing process.** Davenport, F.S. Jul 1977. 163p. NTIS $6.75.

The Interstate Conference on Water Problems (ICWP) is a national association of State, intrastate, and interstate officials concerned with water resources administration and related matters. The Conference was established in 1959 as an outgrowth of regional conferences on water problems as recognized in the same year by action of the General Assembly of the States. This report was produced by the Interstate Conference on Water Problems in an effort to provide a compilation and summary of the views of selected States regarding relationships of water supplies to the nuclear power plant licensing process. This publication does not represent the official position of the U.S Water Resources Council, or the U.S. Nuclear Regulatory Commission, nor does it represent the position of any single state or the ICWP.

ENVIRONMENTAL IMPACT STATEMENTS

REFER ALSO TO CITATION(S) 323, 324

1411 (ERDA—1545-D(Vol.1)) **Rocky Flats Plant Site, Golden, Colorado. Volume I. Draft environmental impact statement.** Sep 1977. vp. Washington, DC.

Two previous environmental statements have been issued for the Rocky Flats Plant site. One concerned a new plutonium recovery facility (WASH-1517, USAEC, January 1972); the second concerned land acquisition (WASH-1518, USAEC, April 1972). This document responds to those who indicated concerns and also ERDA's anticipated concerns about activities associated with the Rocky Flats Plant. Most concerns focus on two points including the Plant's involvement in the production of nuclear weapons and the Plant's handling of hazardous materials, particularly the radioactive element plutonium. The production of nuclear weapons, in which the Rocky Flats Plant maintains a vital role, will probably continue for as long as the world situation suggests that this country must have a strong defense. Operations at the Rocky Flats Plant have resulted in some plutonium being released to the environment, but

evidence does not indicate that the amounts involved have presented any measurable hazard to human health. Ongoing improvements to the Plant's facilities and operational procedures are intended to preclude any recurrence of past releases. Despite these improvements, some public concern has resulted from past releases and the potential adverse effects from any possible future releases. This DEIS addresses that concern. It comments on past mishaps along with their causes and effects. It discusses current operations plus related costs and benefits to the region. Various alternatives to continuing present operations are explored, and the costs and benefits of the different options are compared.

1412 (ERDA—1551) **Nevada Test Site, Nye County, Nevada. Final environmental impact statement.** Sep 1977. 417p. Dep. NTIS, PC A18/MF A01.

This environmental statement for the Nevada Test Site (NTS) considers underground nuclear detonations with yields of one megaton or less, along with the preparations necessary for such detonations. The testing activities considered also include other continuing and intermittent activities, both nuclear and nonnuclear, which can best be conducted in the remote and controlled area of the Nevada Test Site. These activities are listed, with emphasis on weapons testing programs which do not remain static.

1413 (ERDA—1545-D(Vol.2)(App.)) **Rocky Flats Plant Site, Golden, Colorado. Volume 2. Appendices. Draft environmental impact statement.** Sep 1977. vp. Washington, DC.

Data pertinent to the evaluation of the environmental impact of the Rocky Flats Plant are summarized. Included are lists of plants and wild animals; meteorological data; data on the geology, seismology, and hydrology; radiation dose calculations; Pu toxicity; personnel injuries, and radiation accident probabilities.

BIOMEDICAL SCIENCES, BASIC STUDIES

REFER ALSO TO CITATION(S) 1355

1414 (UR—3490-1189) **Annual report, University of Rochester Biomedical and Environmental Research Project: brief description of research papers accepted for publication during 1976.** Nash, D.B. 30 Jun 1977. Contract EY-76-C-02-3490. 111p. Dep. NTIS, PC A06/MF A01.

Brief summaries are presented of some 150 research papers accepted for publication during 1976 that report results of studies in the field of biology, medicine, and the environment.

BEHAVIORAL BIOLOGY

REFER ALSO TO CITATION(S) 1409, 1445, 1522, 1523

1415 (CONS/1830—2) **Biological effects of high strength electric fields. Second interim progress report, September 1976—March 1977.** Phillips, R.D.; Kaune, W.T. May 1977. Contract EY-76-C-06-1830. 116p. Dep. NTIS, PC A06/MF A01.

This report describes progress made on the Project during the period of September 9, 1976 to March 31, 1977 towards the determination of the biological effects of high strength electric fields on small laboratory animals. The efforts to date can be divided into five categories: (1) the design, construction, and testing of a prototype and special studies exposure system; (2) the design and construction of exposure systems for rats and mice; (3) dosimetry; (4) experiments to determine the maximum field strength which does not produce corona discharge, ozone formation, shocks to the animal, hair stimulation, or a behavioral preference by rats to avoid exposure to the field; and (5) preparations for the biological screening experiments.

1416 **Relationship between two stock-recruitment curves.** Eberhardt, L.L. (Battelle Pacific Northwest Labs., Richland, WA). **34**: No. 3, 425-428(Mar 1977).

The Beverton and Holt and Ricker stock-recruitment curves can be used to generate population growth curves. The Beverton and Holt curve is then identical to a difference equation model for the logistic growth curve, and may be derived in terms of equations for linearly density-dependent population regulation. The same equations lead to the Ricker curve if the density-regulating effect is assumed to depend only on population size at the beginning of the interval between generations. At low rates of population growth, the Ricker curve approaches that of Beverton and Holt. The two curves appear to represent certain concepts known in population biology as "r and K selection."

1417 (ORNL-tr—4453) **Body temperature of the burbot.** Poddubnyy, A.G.; Golovanov, V.K.; Malinin, L.K. Translated by S.D. Blalock Jr. from No. 3, 45-48(1976). 3p. Dep. NTIS, PC A02/MF A01.

Records of body temperature of free-swimming fishes were made using miniature temperature sensors. Deviations of temperature of muscles and the intestinal cavity with general and local changes of ambient temperature were studied. Results indicated that the temperature of the intestinal cavity and muscles in the burbot increased from the skin to the inside of the body and differed from the ambient temperature by no more than 0.6°. (HLW)

1418 (ORNL-tr—4451) **Question of the spatial organization of a group of fish during swimming.** Malinin, L.K.; Poddubnyy, A.G. Translated by S.D. Blalock Jr. from No. 29, 57-59(1976). 4p. Dep. NTIS, PC A02/MF A01.

The movements of individuals of a group of carp-bream were analyzed in order to determine how the structure of a school swimming at speeds noted in nature during migrations corresponded to optimum hydrodynamic conditions. Three types of groupings or aggregations are described. The mechanism of formation of migrating schools is partially explained by the hydrodynamics of swimming. (HLW)

BIOCHEMISTRY

REFER ALSO TO CITATION(S) 1436, 1440

1419 (BNWL—2100(Pt.1), pp 217-219) **Siderochrome production, purification a metal binding.** Robinson, A.V.; Pelroy, R.A. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

A new method, involving polyamide chromatography, for quick purification of bacterial siderochromes has been developed and is compared to a previous method using silica gel chromatography and solvent extractions.

1420 (BNWL—2100(Pt.1), pp 245-247) **Characterization of the ATPase of avian myeloblastosis virus.** Schneider, R.P. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

The ATPase of avian myeloblastosis virus is used as a marker to study alterations of the host-cell membrane caused by tumor virus infection and the incorporation of host membrane proteins into virus during maturation. The enzyme, which is presumably derived from the host-cell membrane, remains attached to the virus envelope during detergent treatment which releases 25% of the envelope protein. This suggests that it is an integral component of the envelope matrix. Particles which contain the ATPase, phospholipid and at least nine other proteins have been isolated from cholate-treated virus. The enzyme activity is totally lost when the complex is disassociated; hence purification to a single protein has been impossible to date. If the ATPase is a single polypeptide, it constitutes about 1% of the viral protein.

1421 (BNWL—2100(Pt.1), pp 248-249) **Simplified method for the purification of N. crassa exocellular alkaline protease.** Price, J.S.; Drucker, H. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

A simple method for purification of N. crassa exocellular alkaline protease has been developed, involving one ammonium sulfate fractionation and chromatography on carboxymethylsephadex. The technique results in a 125-fold purification of enzyme with the same specific activity as that reported previously for crystallized enzyme.

1422 (BNWL—2100(Pt.1), pp 249-252) **Protein substrates and amino acid pools in Neurospora crassa.** Price, J.S.; Drucker, H. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

Amino acid pools in N. crassa were measured as a function of carbon starvation and growth on synthetic amino acid mixtures during the course of protease induction under various regimes of starvation and with four different protein substrates. The data suggest a strong correlation between amino acid pool size and qualitative nature and induction of exocellular protease. This implies some degree of coordinate regulation for enzymes of amino acid metabolism and the process of exocellular protease biosynthesis.

1423 (BNWL—2100(Pt.1), pp 253-255) **Density-dependent growth regulation and S-100 protein synthesis in the rat glial cell strain C6 and sublines.** Rupp, R.G.; Winn, L.S.; Wiley, W.R.; Morris, J.E. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

The relationships between density-dependent growth regulation and the cellular accumulation of a brain-specific protein, S-100, was examined in a clonal glial cell culture, C6. The temporal accumulation of S-100 was examined in dense and sparse resting-cell cultures of the parental line C6 and two subcell lines. The data obtained for C6 showed that S-100 is present in exponentially growing cells and that the concentration of S-100 per cell decreases until the exponential phase of growth is concluded, at which time a net accumulation of S-100 per cell occurs. The accumulation of S-100 in sparse and dense cultures was the same qualitatively and quantitatively. Two sublines of C6 isolated by a negative selection procedure grew to 2.5-fold lower saturation densities than the parent cell line, C6. The subcell line accumulated insignificant levels of S-100 in all phases of growth. We conclude from these studies that the synthesis and/or accumulation of S-100 protein may not be inextricably linked to density-dependent inhibition as indicated in previous publications on the subject.

1424 (CONF-770121—2) **Characterization of bile acid metabolism in man using bile acids labeled with stable isotopes.** Hofmann, A.F. Klein, P.D. 1977. Contract W-31-109-ENG-38. 31p. Dep. NTIS, PC A03/MF A01.

From Conference on stable isotopes) applications in pharmacology, toxicology, and clinical research; London, United Kingdom of Great Britain and Northern Ireland (UK) (3 Jan 1977).

Bile acids labeled with stable isotopes in the steroid moiety can be used to characterize bile acid metabolism in man. Isotope dilution studies give information on pool size and input. Biotransformations are easily characterized. Stable isotopically labeled bile acids offer the advantage of freedom from radiation hazard, and also offer the possibility of monitoring all pools simultaneously, since all bile acids are separated by gas chromatography before isotope measurements are made. Further, since the proportion of the pool labeled with stable isotopes is greater than that achieved when radioactive isotopes are used, stable isotopes may permit isotope dilution studies to be done on serum samples in which the absolute concentration of bile acids is very low. A major disadvantage is the complex technology required for stable isotope measurement which often makes remote processing necessary. Bile acid labeled with ^{13}C in the amino acid moiety, e.g. cholylglycine-1-^{13}C can be used for detection of increased bile acid deconjugation by intestinal bacteria, since the glycine-^{13}C, when liberated, is rapidly converted to $^{13}CO_2$, which is expired in breath. Bile acids labeled with stable isotopes may also be used for quantitation by inverse isotope dilution, but the technique is still in the development stage and seems unlikely to compete successfully with radioimmunoassay.

1425 (CONF-770677—1) **Uptake and fate of ouabain bound to HeLa cells.** Cook, J.S.; Brake, E.T. 1977. Contract W-7405-ENG-26. 22p. Dep. NTIS, PC A02/MF A01.

From International conference on drugs, hormones, and membranes; Crans-sur-Sierre, Switzerland (12 Jun 1977).

The first step in the pharmacologic interaction of a cardiac glycoside with cells is the binding of the drug to its specific surface receptor, an exteriorly oriented site of the Na^+—K^+ ATPase. The purpose of the study outlined was to follow a glycoside from its initial binding to its ultimate release from a sensitive cell, and in parallel studies to observe the recovery of the cells from glycoside intoxication. The glycoside used is ^3H-ouabain, and the cells are from the S3 clone of HeLa. HeLa cells are used principally because of their intrinsic interest as a human cell type. In addition, having been cloned, they can be grown as a homogeneous population, which greatly simplifies the interpretation of the results. Finally, after pulse treatment with the drug, the cells can be returned to a complete medium with adequate supplies of serum, amino acids, vitamins, and energy sources. In this normal environment, not only can the short term physiologic responses be assessed but, with the growth requirements of the cells fulfilled, any recovery processes dependent on macromolecular-synthesis can also be observed.

1426 (CONF-770839—1) **Mechanisms in intracellular turnover of stable and labile enzymes.** Kenney, F.T.; Pomato, N.; Lee, K.L. 1977. Contract W-7405-ENG-26. 26p. Dep. NTIS, PC A03/MF A01.

From Symposium on protein turnover and lysosomal function; Buffalo, New York, USA (21 Aug 1977).

We have focused on two proteins of rat liver, one representative of the stable class and probably of reaction mechanisms operative in degradation of all proteins, the other unusually labile and possibly subject to uncommon as well as common mechanisms in turnover. The proteins chosen, tyrosine aminotransferase (E.C. 2.6.1.5) and alanine aminotransferase (E.C. 2.6.1.2) are similar in many respects. They catalyze similar reactions and share a substrate pair (glutamic acid and α-ketoglutarate). Both are located in the soluble fraction of liver cytoplasm. Molecular weights are comparable (tyrosine aminotransferase, 100,000; alanine aminotransferase, 115,000) and both enzymes are structurally dimers of apparently identical subunits each of which binds one molecule of the common coenzyme, pyridoxal phosphate. Metabolically both are inducible by glucocorticoid hormones. But there the resemblance ends, for on the other, degradative side of the metabolic coin the two enzymes are sharply divergent. Tyrosine aminotransferase is among the most labile of liver enzymes, undergoing turnover with a half-life of 1.5 h, while turnover of alanine aminotransferase (half-life about 3 days) is virtually identical to that of the bulk of soluble liver proteins. Recent experimentation designed to determine the mechanistic basis for this difference in metabolism of otherwise quite similar enzymes is reviewed.

1427 (LBL—5634) **Molecular sieving action of the cell membrane during gradual osmotic hemolysis.** MacGregor, R.D. II. May 1977. Contract W-7405-ENG-48. 336p. Dep. NTIS, PC A15/MF A01.

Thesis.

Rat erythrocytes were hemolyzed by controlled gradual osmotic hemolysis to study cell morphology and hemoglobin loss from individual cells. Results suggest that each increase in the rate of loss of a protein from the cells during the initial phases of controlled gradual osmotic hemolysis is caused by the passage of a previously impermeable species across the stressed membrane. Similarly, during the final stages of controlled gradual osmotic hemolysis, each sharp decrease in the rate of loss of a protein corresponds to the termination of a molecular flow. A theoretical model is described that predicts the molecular sieving of soluble globular proteins across the stressed red cell membrane. Hydrophobic interactions occur between the soluble proteins and the lipid bilayer portion of the cell membrane. A spectrin network subdivides the bilayer into domains that restrict the insertion of large molecules into the membrane. Other membrane proteins affect soluble protein access to the membrane. Changes in the loss curves caused by incubation of red cells are discussed in terms of the model.

1428 (SAN—34P61X16) **Metabolic control of transport in plant tissues. Comprehensive progress report (1974—1977).** Laties, G.G. 1977. Contract EY-76-S-0034-061. 24p. Dep. NTIS, PC A03/MF A01.

Studies on cyanide resistance in intact organs included ripening of bananas under hypobaric conditions; the dependence of ethylene responsiveness on the cyanide-insensitive, or alternate path of respiration; and the origin of ripening-related ethylene. Studies on the behavior of tissue slices in relation to cyanide resistance include lipid breakdown and synthesis in potato slices; wound-induced respiration in potato tubers; cyanide insensitive respiration as a superoxide generating electron transport path; and lipid acyl-hydrolases of potato. Studies on mitochondrial behavior included cyanide resistance in mitochondria; enzyme distribution in isolated mitochondria; ATP-ase activity in potato mitochondria; and NADH-linked fumarate reduction. (HLW)

1429 (SRO—635-6) **Mechanisms of energy conversion and transfer in bioluminescence. Progress report, August 15, 1976—November 14, 1977.** Cormier, M.J. 1977. Contract EY-76-C-09-0635. 10p. Dep. NTIS, PC A02/MF A01.

Progress is reported on the following studies: isolation of luciferase and green fluorescent protein (GFP) from Renilla; chemical properties and chemical reactions of luciferase and GFP; and analogy of energy transfer in bioluminescence to energy transfer in photosynthesis. (HLW)

1430 **Chloroplast glutathione reductase.** Schaedle, M. (State Univ. of New York, Syracuse); Bassham, J.A. **59**: No. 5, 1011-1012(May 1977).

Glutathione reductase (EC 1.6.4.2) activity is present in spinach (Spinacia oleracea L.) chloroplasts. The pH dependence and substrate concentration for half-maximal rate are reported and a possible role in chloroplasts is proposed.

1431 **Sites of abscisic acid synthesis and metabolism in Ricinus communis L.** Zeevaart, J.A.D. (Michigan State Univ., East Lansing). **59**: No. 5, 788-791(May 1977).

The sites of abscisic acid (ABA) synthesis and metabolism in Ricinus communis L. were investigated by analyzing the levels of ABA and its two metabolites phaseic acid (PA) and dihydrophaseic acid (DPA) in the shoot tips, mature leaves, and phloem sap of stressed and nonstressed plants. Water stress increased the concentration of ABA, PA, and DPA in phloem exudate and also increased the levels of all three compounds in mature leaves and in shoot tips. The latter had a very high DPA content (18.7 μg/g fresh weight) even in plants not subjected to water stress. When young and mature leaves were excised and allowed to wilt, the level of ABA increased in both, demonstrating that leaves at an early stage of development

have the capacity to produce ABA. These results have been interpreted to mean that in mature leaves of nonstressed Ricinus plants, ABA is synthesized and metabolized, and that ABA itself, as well as its metabolites, are translocated in the phloem to the shoot tips (sinks). Since DPA, but not ABA, accumulates in the shoot tips, it follows that ABA is metabolized rapidly in the apical region. To what extent ABA present in young leaves of nonstressed plants is the consequence of synthesis in situ and of import from older leaves remains to be determined.

1432 Membrane lipids in senescing flower tissue of Ipomoea tricolor. Beutelmann, P.; Kende, H. (Michigan State Univ., East Lansing). **59**: No. 5, 888-893(May 1977).

Rib segments excised from flower buds of Ipomoea tricolor Cav. pass through the same phases of senescence as the respective tissue on the intact plant. Such segments were used to correlate changes in lipid content with known symptoms of aging, such as rolling up of the ribs and ethylene formation. It was found that the level of phospholipid had already started to decline before visible signs of senescence were evident. As the segments began to roll up and to produce ethylene, the rate of phospholipid loss accelerated sharply. During the same period, the level of fatty acids esterified to phospholipids also fell by 40%. No qualitative changes in any lipid component could be detected during senescence. Labeling experiments using ^{33}P as marker showed that the rate at which radioactivity was lost from phospholipids during aging was parallel to the rate at which the level of total phospholipids declined. Exogenously applied ethylene accelerated the loss of phospholipid and the senescence of rib segments while benzyladenine retarded both of these processes. Ag^{+}, which counteracts the effect of ethylene in many plants, inhibited rolling up of the rib segments but did not affect either spontaneous and ethylene-induced ethylene generation, or phospholipid loss. In contrast, Co^{2+}, a purported inhibitor of ethylene synthesis, reduced ethylene production, rolling up, and phospholipid loss. The inhibition of ethylene-induced rolling up by Co^{2+} could not be overcome with exogenous ethylene, however. Our results indicate that phospholipid loss is a marker for membrane degradation in rib segments. Changes in membrane integrity and in cellular compartmentation may be the basis for ethylene synthesis during aging of flower tissue.

CYTOLOGY

1433 (BNWL—2100(Pt.1), pp 184-185) **Ultrastructural studies of alveolar epithelium following tannic acid fixation.** Adee, R.R. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

Additional treatment with tannic acid provides better preservation of biological specimens prepared for transmission electron microscopy. The tannic acid also acts as a mordant for binding heavy metals for obtaining greater contrast. This was demonstrated in the preservation of lamellar bodies of Type II alveolar epithelial cells.

1434 (COO—2423-6) **Studies of membrane structure by freeze-etching. Progress report, 1 July 1976—30 June 1977.** Branton, D. 1977. Contract EY-76-S-02-2423. 6p. Dep. NTIS, PC A02/MF A01.

The structure and organization of biological membranes has been studied using a variety of physical and biochemical techniques together with electron microscopy and freeze-etching. These studies are providing knowledge relating the architecture of cellular membranes to their role in modulating cell behavior in response to environmental perturbants and in regulating the transport of molecules into and out of cells. As model systems, human erythrocyte membranes and their ghosts have been probed to determine the distribution and asymmetry of component lipids and proteins. For this purpose, a novel combination of freeze-fracture and biochemical techniques using fluorescent resonance energy transfer has been developed and tested and ultra low temperature freeze-etching has been evaluated as part of a program to develop covalent labelling techniques that will identify specific transmembrane proteins in freeze-fractured replicas.

1435 (SAN—899X5) **Observations on immunohemopoietic marrow. Annual report, 15 July 1976—14 October 1977.** Crosby, W.H.; Tavassoli, M. 1977. Contract EY-76-S-0899. 13p. Dep. NTIS, PC A02/MF A01.

Progress is reported on the following research projects: polarity of endothelium of marrow sinus membranes; megakaryocyte demarcation membrane system and the mechanism of thrombocytogenesis; culture of marrow and extramedullary adipocytes; ultrastructural studies of hemopoiesis in mice; and separation of erythroid cells. (HLW)

1436 Relationships between hydroxyproline-containing proteins secreted into the cell wall and medium by suspension-cultured Acer psedoplatanus cells. Pope, D.G. (Michigan State Univ., East Lansing). **59**: No. 5, 894-900(May 1977).

The pathway of hydroxyproline-containing proteins to the cell wall and to the growth medium in suspension-cultured Acer pseudoplatanus cells is traced by following the kinetics of the transfer of protein-bound ^{14}C-hydroxyproline into various fractions, and by comparing the hydroxyproline-arabinoside profiles of these fractions after alkaline hydrolysis. Hydroxyproline-rich protein passes directly from a membrane-bound compartment in the cytoplasm to the cell wall, not via an intermediate salt-soluble pool in the wall. There are at least three hydroxyproline-containing glycoproteins in the cell wall. One which possesses mono-, tri-, and tetraarabinoside side chains accounts for over 90% of the total hydroxyproline. This glycoprotein is "extensin." The hydroxyproline-containing proteins secreted into the medium have a glycosylation pattern markedly different from that of the major cell wall glycoprotein. It appears that there is little or no wall-like extensin in the medium. Approximately half of the protein-bound hydroxyproline secreted into the medium is linked to an arabinogalactan. This linkage is also found in a particulate wall protein precursor fraction from the cytoplasm, but only trace amounts can be detected in the cell wall.

1437 Hayflick's hypothesis: an approach to in vivo testing. Reincke, U.; Burlington, H.; Cronkite, E.P.; Laissue, J. (Brookhaven National Lab., Upton, NY). pp 137-147 of In Biology of aging and development. Thorbecke, G.J. (ed.). New York; Plenum Publishing Corp. (1975).

From 58. annual meeting of the Federation of American Societies for Experimental Biology; Atlantic City, NJ, USA (10 Apr 1974).

The experimental evidence relating to the hypothesis of finite cellular life is reviewed. It is emphasized that even if somatic cell production were limited its total potential would have to be vast to provide for extensive cellular regeneration. The actual limit of reproductive cell life would therefore not likely be reached in a normal life-span. It is proposed to test the hypothesis by deliberate exhaustion of stem-cell reserve, and iron-55 cytocide is described as an experimental system that might be applicable.

GENETICS

REFER ALSO TO CITATION(S) 1497, 1524, 1526

1438 (BNWL—2100(Pt.1), pp 269-271) **Are mutations induced by electic fields.** Hungate, F.P.; Richardson, R.L.; Gillis, M.F. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

This report summarizes progress made during the first year in a study of the mutagenicity of electric fields. Several bacterial strains and the fruit fly, Drosophila, have been studied for evidence of mutagenicity following exposure to dc fields up to 10 kV/cm. Initial data suggest a mutagenic response following exposure of dividing cell systems in the higher-strength fields but the present data are not sufficiently consistent to relate effect to dose.

1439 (COO—2384-7) **Studies of the genetic material of some RNA viruses. Final report.** Siegel, A. 1977. Contract EY-76-S-02-2384. 10p. Dep. NTIS, PC A02/MF A01.

Studies of the genetic material of some RNA viruses showed that strains of the plant virus, TMV, fall into groups and within a group there is no appreciable nucleotide sequence divergence between the strain RNAs. A study was initiated into the molecular biology of replication of the POTY plant virus group that includes tobacco etch virus.

1440 (COO/2725—2) **Repair of DNA treated with γ-irradiation and chemical carcinogens. Progress report, February 1, 1976—February 28, 1977.** Goldthwait, D.A. 1977. Contract EY-76-S-02-2725. 26p. Dep. NTIS, PC A03/MF A01.

Enzymes from E. coli which recognize damage in DNA due to chemical carcinogens and γ-irradiation are under study. Endonuclease II, which recognizes DNA treated with methylmethane sulfonate, methylnitrosourea, 7-bromomethyl-12-methylbenz[a]anthracene and γ-irradiation. Apurinic endonuclease (endonuclease VI) recognizes apurinic and apyrimidinic acid sites. These enzymes have now been purified to homogeneity and separated from exonuclease III which other groups have thought to be identical with one or both of the endonucleases. A series of mutants of E. coli were found to lack one, two, or all of these enzymes. The genetic loci for the two endonucleases are very close to the Exonuclease III locus at 38.2 minutes. An attempt to relate in vivo sensitivity to MMS to lack of specific enzymes has been made. Substrates for endonuclease II have been examined. β-propiolactone

treated DNA has been found to be substrate and details of this are being examined. The nature of the lesion in γ-irradiated DNA is under investigation. A search for mammalian enzymes which are N-glycosidases is underway.

1441 (ORO—4023-8) **Progress report on studies of drosophila dispersal and species packing.** Richardson, R.H.; Johnston, J.S. 26 Jul 1977. Contract EY-76-S-05-4023. 8p. Dep. NTIS, PC A02/MF A01.

The research in progress falls into three areas, gamodeme studies in Hawaiian Drosophila, dispersal studies in Drosophila, and neutron activation analysis technique development. The development and use of new multivariate statistical analysis for electrophoretic data to identify gamodemes are underway. Community evolution and stability were discussed in a full-day symposium on biological control held at the annual meetings of the Texas Academy of Science. There were two papers which were derived from research supported by this contract. The focus was on the readjustments made in species which were caused by environmental perturbations which drive one species to extinction or near extinction in a local area. Differences to be expected in marginal and central populations, and the community composition involving sibling (and cryptic) species were emphasized. The net effect could be the development of a worse pest problem after a control program is well advanced than before the control program began. However, properly conducted species surveys which can identify cryptic species, whose competitive interactions may be somewhat more plastic than unrelated species, should identify possible hazardous communities for generating pest outbreaks.

METABOLISM

REFER ALSO TO CITATION(S) 1427, 1428, 1431, 1550, 1551, 1553, 1554

1442 (BNWL—2100(Pt.1), pp 110-111) **Postnatal development of the rat thyroid gland.** Daniel, J.L. Jr.; Goldman, M.; Mahlum, D.D.; Sikov, M.R. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

The postnatal development of the rat thyroid gland is being studied histologically and by autoradiography after tritiated thymidine injection. The second week of life appears to be the period of greatest cell proliferation and growth of follicles. It appears that new follicles are formed by subdivision of existing follicles, as well as by organization of interfollicular cells into new follicles.

1443 (BNWL—2100(Pt.1), pp 147-150) **Absorption of pollutant metals in iron-deficient rats.** Ragan, H.A. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

The gastrointestinal absorption of selected heavy metals was evaluated in rats with depleted tissue-iron stores and enhanced iron absorption, but prior to the development of severe anemia. The total body burden of lead, cadmium, mercury and zinc was significantly greater in iron-deficient rats than in litter-mate controls, whereas no difference in arsenic absorption was evident between the two groups. Control rats absorbed more vanadium than iron-deficient rats.

1444 (BNWL—2100(Pt.1), pp 161-165) **H_2 production from glucose by the photosynthetic bacterium, Rhodopseudomonas spheroides.** Pelroy, R.A. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

Hydrogen production from the photosynthetic decomposition (photodissimilation) of glucose by R. spheroides has been increased more than 4-fold by selection of a glucose-utilizing mutant; i.e., one capable of using the sugar as its sole source of carbon and energy. Physiological measurements of the effect of various gases and various soluble nitrogen sources implicate cellular nitrogenase as the enzyme which synthesizes hydrogen gas.

1445 (COO—2270-5) **Energy budgets of animals: behavioral and ecological implications. Progress report.** Porter, W.P. Jun 1977. Contract EY-76-S-02-2270. 45p. Dep. NTIS, PC A03/MF A01.

Progress is reported on the following studies: growth and reproduction of lizards; temperature and soil moisture requirements for egg hatching; metabolism measurements of developing eggs; factors controlling growth rate; longevity studies of lizards; growth and reproduction of deer mice with different levels of food and water deprivation; and critical densities of spines of cactus. (HLW)

1446 (TID—27706) **Physiological differences beween fertilized and unfertilized mouse ova: glycerol permeability and freezing sensitivity.** Jackowski, S.C. Mar 1977. Contract W-7405-ENG-26. 126p. Dep. NTIS, PC A07/MF A01.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

The glycerol permeability and freezing sensitivity of mouse ova were studied for evidence of differences associated with fertilization. The times of ovulation, fertilization and first cleavage of ova were determined as a function of time after the administration of human chorionic gonadotropic, hormone, HCG, to female mice. Fertilization did not cause a large instantaneous change in glycerol permeability. Rather, the permeability coefficient for glycerol at approximately 3°C gradually increased from 7.0×10^{-7} to 7.0×10^{-6} cm/min for fertilized ova isolated from about 1 hour to 16 hours after fertilization. The zonae pellucidae of fertilized and unfertilized ova did not act as detectable barriers to permeation by glycerol. No significant and immediate change was observed on the surface of the ovum as a result of fertilization. Survival after freezing was assayed by two techniques: measurement of the ability of the cells to fluoresce in the presence of fluorescein diacetate; successful development in culture. Survival of fertilized and unfertilized ova increased as a function of both the temperature and time of incubation in glycerol prior to freezing. It was concluded that permeation of a cell by glycerol enhances survival. The cooling rate that yielded optimal survival of zygotes in G_2 phase differed from that of unfertilized ova and zygotes in G_1 phase. The optimum rate for the latter cells was about 1°C/min with survival being about 63 percent and 79 percent, respectively. The optimum rate for zygotes in G_2 ranged from 1°C/min to 7°C/min with survival being about 58 percent. The differences among the freezing sensitivities of unfertilized ova, zygotes in G_1 and zygotes in G_2 can be explained in terms of their differences in glycerol permeability and possibly in terms of the increased surface area associated with the number of microvilli on the G_2 zygotes.

1447 (TID—27742) **Concentrations of intracellular nutrients and rates of photosynthesis in algae. Final report, September 1, 1975—November 30, 1976.** Megard, R.O. Jul 1977. Contract EY-76-S-02-1820. 19p. Dep. NTIS, PC A02/MF A01.

The photosynthetic activity at saturating irradiances of chlorophyll a (P/sub opt/) in the green alga Chlorella and two blue-green algae Anabaena and Oscillatoria depends upon the ratio (phi) of cellular phosphorus to chlorophyll a according to an equation for a hyperbola of the form, P/sub opt/ = P/sub max/ (1 - K/sub phi//phi). Maximal rates of photosynthesis at saturating irradiance and saturating cellular phosphorus (P/sub max/) and also subsistence concentrations of cellular phosphorus (K/sub phi/) for the two blue-green algae are higher than for the green alga. A mechanistic model for rates of photosynthesis was formulated. It describes inhibition at high light intensities, and it also describes adequately the families of photosynthesis-light curves that were produced by altering cellular phosphorus. The specific rate of photosynthesis (P) attains a theoretical maximum (P/sub max//sup t/) when both light (I) and nutrients are saturating, and it decreases to zero when the limiting cellular nutrient (phi) decreases to K/sub phi/ or light decreases to zero: $P = [(P/sub\ max//sup\ t/\ (1 - K/sub\ phi//phi)I]/[K_1\ (1 - K/sub\ phi//phi) + K_2 + I + K_3I^2]$. The analysis improves our understanding of the photosynthetic mechanisms by which solar energy is transformed to algal biomass. It demonstrates that the photosynthetic activity of chlorophyll a is intrinsically higher and also much more responsive to cellular phosphorus in some species, such as Anabaena and Oscillatoria, than it is in other species, such as Chlorella.

1448 **Nitrite uptake by nitrogen-depleted wheat seedlings.** Jackson, W.A.; Johnson, R.E.; Volk, R.J. (North Carolina State Univ., Raleigh). **32**: 37-42(1974).

Intact, 14-day-old nitrogen-depleted wheat (Triticum vulgare cv. Blueboy) seedlings were exposed to solutions of 0.5 mM KNO_2, 0.05 mM $CaSO_4$ and 1 mM sodium 2-[N-morpholino]-ethanesulfonate, pH 6.1. Nitrite uptake was determined from depletion of the ambient solution or from incorporation of ^{15}N in the tissue. An initial nitrite uptake shoulder was followed by a relatively slow uptake rate which subsequently increased to a substantially greater rate. This accelerated phase was maintained through 24 h. Nitrite accumulated to a slight extent in the root tissues during the first few hours but declined to low values when the accelerated rate was fully developed, indicating an increase in nitrite reductase activity paralleling the increase in nitrite uptake capacity. About 50% of the nitrogen absorbed as nitrite was translocated to the shoots by 9 to 12 h. Development of the accelerated nitrite uptake rate was restricted in excised roots, in intact plants kept in darkness, by 400 μg puromycin ml^{-1} and by 1 mM L-ethionine. When puromycin and L-ethionine were added after the accelerated phase had been initiated, their effects were not as detrimental as when they were added at first exposure to KNO_2. The two inhibitors restricted translocation more than uptake. The data indicate an involvement of protein synthesis and a requirement for movement of a substance from shoots to roots for maximal development of the accelerated nitrite uptake phase. A requirement for protein synthesis in the transport of soluble organic nitrogen from roots to shoots is also suggested.

MEDICINE

1449 (BNL—23037) **Effect of sodium fluoride on skeletal mass in primary osteoporosis.** Zanzi, I.; Aloia, J.; Ellis, K.; Cohn, S. 1977. Contract EY-76-C-02-0016. 3p. (CONF-770731—1). Dep. NTIS, PC A02/MF A01.

From Symposium on trace element metabolism in man and animals; Freising-Weihenstephan, F.R. Germany (25 Jul 1977).

The administration of NaF plus Ca to a group of eleven patients with primary osteoporosis did not result in an increase in TBCa as measured by TBNAA or in BMC by photon absorptiometry. However, the group of osteoporotic patients receiving Ca alone differed significantly from the group receiving NaF, with initial increase in TBCa, although the treatment of Ca was maintained for only one year. A possible explanation for the lack of effect of NaF here and the previously reported beneficial effect may be the absence of concomitant administration of vitamin D. However, no clinical or consistent laboratory manifestation of osteomalacia were observed in the patients.

1450 (ANL-Trans—1100) **Method of bone microradiography.** Aliev, S.G. Translated from **42**: No. 3, 98-100(1967). 6p. Dep. NTIS, PC A02/MF A01.

A method is described for the microradiography of bone tumors in nondecalcified bones removed during surgery. The microradiograms obtained were studied under a microscope for evidence of pathological bone formation and its distribution in osteosarcoma.

TRACER TECHNIQUES

1451 (BNWL—2100(Pt.1), pp 256-257) **Radioimmune assays for S-100 protein.** Morris, J.E.; Winn, L.S.; Wiley, W.R. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

A double-antibody radioimmune assay was developed for quantitating S-100 protein in tissue and tissue culture preparations. The sensitivity of the assay was in the low nanogram range.

1452 (UCLA—12-1124) **Imaging sites of airway obstruction and measuring function response to bronchodilator therapy in asthma.** Chopra, S.K.; Taplin, G.V.; Tashkin, D.P.; Trevor, E.; Elam, D. 1977. Contract EY-76-C-03-0012. 23p. Dep. NTIS, PC A02/MF A01.

The sites of airway dilatation following inhalation and systemic injection of terbutaline were compared in twelve asthmatic subjects. Baseline studies included functional tests of large and small airway obstruction and two inhalation radionuclide lung imaging procedures (xenon-133 gas single breath and washout examination, followed by Tc-99m sodium pertechnetate aerosol imaging.) On each of three study days, subjects were treated in a random, double-blind fashion with either: aerosolized terbutaline + subcutaneous (SC) saline; aerosolized saline + SC terbutaline; or aerosolized saline + SC saline (placebo). Ten to thirty minutes after each treatment regimen functional tests and lung imaging were repeated. Inhaled terbutaline gave evidence of large airway dilatation on both function tests and lung images in nine of twelve subjects and of small airway dilatation in only five.

1453 **Metal isotopes used as radioactive indicators of ocular melanoma.** Packer, S.; Lambrecht, R.M.; Christman, D.R.; Ansari, A.N.; Wolf, A.P.; Atkins, H.L. (Brookhaven National Lab., Upton, NY). **83**: No. 1, 80-94(Jan 1977).

We studied radioactive metal compounds to determine their localization in malignant Greene melanoma in the eye of the Syrian golden hamsters. Scintigraphy of an ocular melanoma was achieved with several radioactive metals: radioactive (^{111}In)-bleomycin, radioactive gallium (^{67}Ga)-citrate, and radioactive lead (^{203}Pb)-tris. The ^{111}In-bleomycin had the highest tumor uptake (5.45% dose/g), but not the highest tumor-to-background ratios. The ^{67}Ga-citrate had a maximum tumor uptake of 4.87% dose/g at 48 hours. The ^{111}In-chloride had a melanoma uptake of 2.26% dose/g, while with ^{203}Pb-tris the uptake was 1.61% dose/g. These uptake ratios compare favorably with that of radioactive phosphorus (^{32}P) - 2.21% dose/g. Noninvasive localization of malignant melanoma in the eye was accomplished with metal isotopes. Detailed analysis of in vitro uptake data by tumor and background tissues revealed the optimum time for scanning and precluded unnecessary trials.

1454 **Continuously variable line phantom for quality assurance.** Brunsden, B.S.; Beck, R.N.; Charleston, D.B. (Chicago Univ., Ill. (USA); Franklin McLean Memorial Research Inst., Chicago, Ill. (USA)). pp v.1 p.43-53 of In Medical radionuclide imaging. Vienna; IAEA (1977).

From International symposium on medical radionuclide imaging; Los Angeles, Calif., USA (25 - 29 Oct 1976).

A type of phantom has been developed which produces parallel-line patterns with continuously variable periodicity by a Moire method. Two identical parallel-line grids, having a period below the resolution capability of current scintillation cameras, are superimposed and rotated relative to each other, producing a pattern of parallel lines ranging smoothly from a 50-mm period at 3° to a 5-mm period at 30° rotation. This phantom's capability of showing the variations of resolution across the crystal allows adjustment or preventive maintenance to be initiated before image quality is noticeably degraded. Being continuously adjustable, this test phantom can be used for daily monitoring of the performance of scintillation cameras having a wide range of resolution limits.

MICROBIOLOGY

1455 (ORNL-tr—4403) **Bacteria adsorption on glass, modified glass surfaces and polymer films.** Pertsovskaya, A.F.; Zvyagintsev, D.G. Translated by S.D. Blalock Jr. from No. 3, 100-105(1971). 8p. Dep. NTIS, PC A02/MF A01.

It is shown that some microorganisms (cocci, most of the mycobacteria) are adsorbed with identicl intensity on adsorbents that totally differ with respect to their properties, other cultures (most of the nonsporiferous bacteria) are adsorbed selectively on various adsorbents, and still others are not adsorbed or are weakly adsorbed on all surfaces. The adsorption properties of cells can sharply change depending on the developmental phase of the culture. Live cells and cells killed by autoclaving usually have identical adsorption properties. A certain relationship is established between adsorption on different surfaces and the systematic position of microorganisms. It is shown on the basis of a large assortment of Escherichia coli strains that the adsorption properties of different strains can differ sharply.

PATHOLOGY

1456 (COO—910-44) **Brief communication: evidence that B lymphocytes carry the nuclear pocket abnormality associated with bovine leukemia virus infection.** Pomeroy, K.A.; Paul, P.S.; Weber, A.F.; Sorensen, D.K.; Johnson, D.W. 1976. Contract EY-76-S-02-0910. 13p. (CONF-761185—1). Dep. NTIS, PC A02/MF A01.

From 57. conference of research workers in animal diseases; Chicago, Illinois, USA (29 Nov 1976).

Peripheral blood lymphocytes from three cows with persistent lymphocytosis were separated on nylon wool columns into nylon wool adherent and nonadherent populations. The percentage of cells coated with surface immunoglobulin and the frequency of lymphocytic nuclear pockets in each subpopulation were then determined. In each case the adherent population consisted predominantly of B cells with an increased nuclear pocket frequency while the non-adherent cells were 98 to 99 percent surface immunoglobulin negative and contained essentially no nuclear pockets. These findings provide additional evidence that the B subpopulation of cells is highly involved in bovine leukemia oncogenesis.

1457 (ORNL/TM—5934) **High resolution ultrasonic scanning of animal and human tissue in-vivo.** Roswell, R.L.; Goans, R.E.; Cantrell, J.H. Jr. Aug 1977. Contract W-7405-ENG-26. 93p. Dep. NTIS, PC A06/MF A01.

Thesis. Submitted by R.L. Roswell to Renesselear Polytechnic Inst.

Burns impose one of the most serious injuries to the skin due to the organ's function within the body system and to the body as a whole. In an effort to better deal with the burn wound by the immediate excision and grafting of third degree burns, a high resolution (approximately 0.2 mm) ultrasonic pulse-echo technique was developed for determining burn depth. The experimental subjects were Yorkshire pigs because of the histological similarity between human and porcine skin. Burn depths were readily identifiable immediately postburn with the ultrasonic techniques, as were general trends concerning the burn-viable and viable-fat interfaces. The tissue characteristics, density and acoustic attenuation, effecting the impedance mismatch at the burn-viable tissue interface were investigated. The methods of fluid displacements and specific gravities yielded density values, while spectrum analyses produced attenuation measurements for normal, viable and burned tissue samples.

PHYSIOLOGICAL SYSTEMS

1458 **Effect of stress on blood coagulation and haematology in rainbow trout (Salmo gairdneri).** Casillas, E.; Smith, L.S. (Univ. of Washington, Seattle). **10**: No. 4, 481-491(25 Mar 1977).

The effect of short-term stress on blood clotting times, cell counts, hematocrits, and blood glucose levels was studied in a hatchery strain and wild type rainbow trout, Salmos gairdneri.

Blood clotting times declined and thrombocyte counts, hematocrits, and blood glucose levels increased after stress in both strains of trout. The wild type of rainbow trout, however, required less time to recover from the stress than the hatchery strain of rainbow trout. The implications of a stress activated blood coagulation system in fish are discussed.

1459 (ORNL-tr—4452) **Individual differences in the swimming capability of carp and the effect of starvation on it.** Pavlov, D.S.; Malinin, L.K.; Chernousov, A.N. Translated by S.D. Blalock Jr. from No. 30, 26-29(1976). 4p. Dep. NTIS, PC A02/MF A01.

Measurements of swimming time of fishes were made in a trough in which a current was created by electric motors. The length of swimming time of individual specimens varied within large limits. When fish were not fed for 18 days the swimming time decreased sharply and restoration of feeding led to rapid recovery. (HLW)

TRACER TECHNIQUES

1460 (UCID—12-1125) **Mathematical basis for the application of probability theory to tracer kinetics.** Huang, S.C.; Cox, J.R. Jr. 1977. Contract EY-76-C-03-0012. 34p. Dep. NTIS, PC A03/MF A01.

A mathematically rigourous basis for the application of probability theory to transit-time studies in tracer kinetics is developed. A stochastic formulation for transit-time distributions of nondiffusible tracers is shown. The formulation relates the transit-time distributions with the structural characteristics of a flow system. Examples are given to illustrate the usefulness of the formulation for obtaining analytical forms of transit-time distributions through flow systems.

AGRICULTURE AND FOOD TECHNOLOGY

REFER ALSO TO CITATION(S) 1037, 1318

BIOMEDICAL SCIENCES, APPLIED STUDIES

RADIATION EFFECTS ON BIOCHEMICALS

IN VITRO

REFER ALSO TO CITATION(S) 1464

1461 (BNWL—2100(Pt.1), pp 234-235) **Tests for mutagencity of free radicals formed in irradiated sugars and amino acids.** Kalkwarf, D.R.; Pelroy, R.A. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

Radicals formed in gamma-irradiated crystals of galactose and glycine were found, upon dissolution, to cause mutagenesis of Salmonella typhimurium strains TA-98 and TA-100. Although the reproducibility of the results has not been adequately determined, they suggest the possibility of developing a test to measure the mutagenic-carcinogenic potential of radiation-induced free radicals with a microbial system.

1462 (BNWL—2100(Pt.1), pp 236-238) **Lysis of phespholipid membranes with radiation-induced free radicals.** Kalkwarf, D.R.; Frasco, D.L. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

Phospholipid vesicles were found to be lysed by exposure to free radicals derived from irradiated glycine and galactose. The decomposition yield increased with vesicle concentration, and attained values of 0.0006 vesicles destroyed per radical added. Ionic charge at the phospholipid end groups was found to be more important than degree of unsaturation in determining this yield. Radicals derived from irradiated serine and alanine had no detectable lytic action at the vesicle concentrations tested.

IN MICROORGANISMS

REFER ALSO TO CITATION(S) 1440

RADIATION EFFECTS ON CELLS

EXTERNAL SOURCE

1463 (CONF-770718—4) **Application of mammalian cytogenetics to mutagenicity studies.** Brewen, J.G. 1977. Contract W-7405-ENG-26. 11p. Dep. NTIS, PC A02/MF A01.

From Symposium on actions of physical and chemical mutagens on the somatic chromosomes of man; Edinburgh, United Kingdom of Great Britain and Northern Ireland (UK) (7 Jul 1977).

Studies on induction of chromosome damage in germ cells by triethylene melamine (TEM) included determination of frequencies of chromosomal aberrations observed in human leukocytes after treating different stages of the cell cycle with TEM, frequencies of chromatid aberrations in metaphase I oocytes and the female pronuclear chromosomes following treatment of female mice with TEM, and frequencies of labeled diplotene-diakinesis figures and chromosome abberations at various intervals after treatment of primary spermatocytes with TEM and ^{3}H-thymidine. Studies on effects of low linear energy transfer radiation on mouse oocytes showed that the frequency of aberrations increased as a function of time and remained constant 8 to 9 days post-exposure. It was concluded that cytogenetic procedures were adequate to evaluate certain mutagenic end points. (HLW)

1464 (COO—2364-12) **Mechanisms for radiation damage in DNA constituents and DNA.** Sevilla, M.D. 1977. Contract EY-76-S-02-2364. 11p. (CONF-770346—2). Dep. NTIS, PC A02/MF A01.

From Symposium on excited states in organic and biochemistry; Jerusalem, Israel (28 Mar 1977).

The initial effects of all forms of ionizing radiation on DNA are the production of positive ions, negative ions, and excited states of the DNA bases. These species may later react to produce biologically significant damage. The reactions of ion radicals produced individually in DNA bases are reviewed. In this discussion emphasis is placed on the initial events immediately after ionization, i.e., the fate of the electron and positive hole in irradiated DNA. A number of techniques which have been used to produce ion radicals in DNA bases for ESR studies are described.

1465 (UCRL—79664) **Flow cytogenetics: progress toward chromosomal aberration detection.** Carrano, A.V.; Gray, J.W.; Van Dilla, M.A. 1 Jul 1977. Contract W-7405-ENG-48. 28p. (CONF-770718—2). Dep. NTIS, PC A03/MF A01.

From Symposium on actions of physical and chemical mutagens on the somatic chromosomes of man; Edinburgh, United Kingdom of Great Britain and Northern Ireland (UK) (7 Jul 1977).

Using clonal derivatives of the Chinese hamster M3-1 cell line, we demonstrate the potential of flow systems to karyotype homogeneous aberrations (aberrations which are identical and present in every cell) and to detect heterogeneous aberrations (aberrations which occur randomly in a population and are not identical in every cell). Flow cytometry (FCM) of ethidium bromide stained isolated chromosomes from clone 650A of the M3-1 cells distinguishes nine chromosome types from the fourteen present in the actual karyotype. X-irradiation of this parent 650A clone produced two sub-clones with an altered flow karyotype, that is, their FCM distributions were characterized by the addition of new peaks and alterations in area under existing peaks. From the relative DNA content and area for each peak, as determined by computer analysis, we predicted that each clone had undergone a reciprocal translocation involving chromosomes from two peaks. This prediction was confirmed by Giemsa-banding the metaphase cells. Heterogeneous aberrations are reflected in the flow karyotype as an increase in background, that is, an increase in area underlying the chromosome peaks. This increase is dose dependent but, as yet, the sample variability has been too large for quantitative analysis. Flow sorting of the valleys between chromosome peaks produces enriched fractions of aberrant chromosomes for visual analysis. These approaches are potentially applicable to the analysis of chromsomal aberrations induced by environmental contaminants.

1466 **Organization of repeated nucleotide sequences in the replicons of mammalian DNA.** Mattern, M.R.; Painter, R.B. (Univ. of California, San Francisco). **19**: No. 2, 117-123(Aug 1977).

Chinese hamster ovary cells were irradiated with 100 to 5,000 rads of x-rays, and inhibition of the initiation of replicons after irradiation was demonstrated by analyzing nascent DNA sedimented in alkaline sucrose gradients. The renaturation kinetics of DNA synthesized during 60 min of incubation after irradiation was compared with that of DNA synthesized during the 60 min after sham irradiation and with that of parental DNA. Nascent DNA from cells whose replicon initiation was inhibited renatured faster than nascent DNA from control cells in the C_0t range of repeated nucleotide sequences, suggesting that regions of the replicon not close to origins are enriched in repeated sequences and that regions close to origins are enriched in unique sequences. A class of repeated nucleotide sequences may be involved in the regulation of replicon initiation.

RADIATION EFFECTS ON MICROORGANISMS

BASIC STUDIES

1467 (COO—3571-17) **Effects of radiations on DNA and repair of the damage. Progress report, May 1, 1976—March 31, 1977.** Hutchinson, F. 1977. Contract EY-76-S-02-3571. 7p. Dep. NTIS, PC A02/MF A01.

Last year's report that repair of DNA double-strand breaks from gamma rays occurs in E. coli was verified by additional experiments. Such repair requires recA function and the presence of another DNA molecule of the same base sequence, so it may involve a recombination-like event. Ultraviolet light acting on DNA containing bromouracil produces double-strand breaks by single photochemical events, and a single model can explain this as well as other results. Strains of E. coli which are unusually mutable by bromouracil--uvrE, mutL, mutR, mutS, are defective in mismatch repair. This strengthens the suggestion in last year's report that such mutagenesis occurs when enzymes responsible for the removal of mismatched bases are unable to remove all the mismatches. Ultraviolet mutagenesis of lambda phage may be a useful model for the study of mutagenesis in cells, because the effects of lesions in the gene mutated (i.e., in the phage) and changes in enzyme systems (by treating the host cells) can be examined separately. Quantitative data support this approach.

1468 **Bromodeoxyuridine incorporation as a probe for studying the nature of radiation response of the slime mold, Physarum polycephalum.** Breckbill, V.A. Cleveland; Case Western Reserve Univ. (1976). 109p. University Microfilms Order No. 77-11,940.

Thesis (Ph. D.).

The effect of the incorporation of 5-bromodeoxyuridine into DNA on the induction of mitotic delay by radiation was studied in the synchronously dividing slime mold, Physarum polycephalum, in its vegetative stage, in an attempt to relate this radiation response to DNA damage. 5-Bromodeoxyuridine was incorporated into the DNA of Physarum polycephalum during (1) the first DNA synthesis period (S-I) following Mitosis I (first mitosis after fusion of microplasmodia) and the extent of unifilar substitution of deoxythymidine by 5-bromodeoxyuridine prior to Mitosis II was determined to be approximately 45%; or (2) the DNA synthetic periods following Mitosis I and Mitosis II (S-I and S-II) and the extent of bifilar substitution of deoxythymidine by 5-bromodeoxyuridine prior to Mitosis III was determined to be approximately 75%. There were significant increases in radiation induced mitotic delay observed in the molds (unifilar substitution) that had incorporated 5-bromodeoxyuridine from medium containing 100 μg/ml compared to nonsubstituted molds. There were significant increases in the radiation induced mitotic delay at Mitosis IV (with bifilar substitution) in plasmodia that had been grown in medium containing 25 μg/ml of 5-bromodeoxyuridine. When DNA from irradiated molds (harvested during S-II or G_2-II after 40,000 R) was subjected to alkaline sucrose density gradient centrifugation, it was found that the DNA from plasmodia treated with 5-bromodeoxyuridine initially contained more strand breaks than the similarly irradiated control molds. This difference was statistically significant in G_2 and suggests a correlation between the greater initial strand break damage observed in G_2 and the enhancement of radiation induced mitotic delay in the premitotic interval of G_2. No such correlation can be made for events in S with the results of the present study.

1469 **Energy dependence of mutations produced in Escherichia coli by low doses of x-radiation.** Bartlett, W.T. College Station, TX; Texas A and M Univ. (1976). 58p. University Microfilms Order No. 77-12,525.

Thesis (Ph. D.).

Resistance to the proline analogue, azetidine-2-carboxylic acid, was used as a selection technique with E. coli in order to measure the production of mutations caused by low doses of x-radiation. An improved procedure was required to measure the small changes in the mutation rate. Since the Coulter Counter provided a precise estimate of bacterial numbers, it was found to be essential in this procedure. In addition, a system for producing K x-rays and highly filtered x-rays was developed. This system produced x-rays of good homogeneity whose quality could easily be defined. Bacterial cultures received exposures from 10 R to 138 R at various energies from 29 keV to 88 keV. X-ray exposure at the 29 keV energy produced a significant increase in the bacterial mutation rate. Exposure at 37 keV and 58 keV caused a significant decrease in the bacterial mutation rate. Bacterial cultures showing logarithmic growth were much more sensitive to irradiation than cultures in a non-growing state. Mutants were characterized by reversion with the alkylating agent ethyl methane sulfonate (EMS) and the less specific, but more potent, agent N-methyl-N′-nitro-N-nitrosoguanidine (NTG). EMS reverted the spontaneously occurring mutants and those produced by exposure to 29 keV x-rays more readily than mutants produced by exposure to higher energy x-rays. No correlation was observed with NTG reversion. The data in these experiments indicate that the rate and type of mutations produced by low doses of x-rays were energy dependent.

1470 **Studies of near-ultraviolet radiation induced growth delay in Escherichia coli.** Ramabhadran, T.V. Dallas; Univ. of Texas (1975). 175p. University Microfilms Order No. 76-8617.

Thesis (Ph. D.).

Sublethal fluences of near-ultraviolet radiation (near uv, 300-380 nm) induce a transient growth inhibition in Escherichia coli. The studies in this dissertation were aimed at elucidating the mechanism of near-uv-induced growth delay in E. coli. Near uv has been shown to induce pyrimidine dimers, alkali-labile bonds, and probably other repairable lesions in DNA. We have shown that growth delay is not photoreactivable and that the extent of growth delay is independent of the dark-repair capacity of the cell, indicating that repairable lesions in DNA are not involved in growth delay. Examination of DNA, RNA, and protein syntheses in near-uv-irradiated E. coli B/r revealed a sharp curtailment of RNA accumulation, the effect on DNA and protein syntheses being milder. The action spectrum for the inhibition of net RNA synthesis suggested the absorption of near uv by 4-thiouridine (^{4}Srd), a modified nucleoside in the 8 position of many tRNA's which absorbs in the near uv, to be the cause of inhibition of RNA accumulation. In vitro studies of Favre and others have shown that irradiation of ^{4}Srd-containing tRNA induces an adduct between this base and a Cytosine at 13 position thereby lowering acylation rate of the tRNA, and incorporation of the corresponding amino acid into polypeptides. ^{4}Srd is present in 60-65% of E. coli tRNA and about 75% of these tRNA form ^{4}Srd-Cyd adducts. These considerations led us to suggest that near uv induces an amino acid starvation by decreasing the levels of acylated tRNA and that this leads to the inhibition of RNA accumulation as in "stringent response". As observed during an amino acid starvation, the addition of chloramphenicol to near-uv-irradiated cells causes a resumption of RNA accumulation. ^{4}Srd-Cyd adducts formed in tRNA in vitro by near-uv irradiation have been characterized and the kinetics of its formation have been measured in vitro by Favre and others.

RADIATION EFFECTS ON ANIMALS

MAN

REFER ALSO TO CITATION(S) 1373

1471 (BNL—23150) **Rationale for nonlinear dose response functions of power greater or less than one.** Baum, J.W. Aug 1977. Contract EY-76-C-02-0016. 8p. (CONF-770663—1). Dep. NTIS, PC A02/MF A01.

From Workshop on repair mechanisms and exposure standards; Oak Ridge, Tennessee, USA (28 Jun 1977).

Risk estimates and radiation protection standards are generally made using a nonthreshold premise and linear extrapolations from existing data to estimate biological radiation effects at lower doses and at lower dose rates. This seems reasonable in light of the variety of shapes of dose-effect relations which have been observed both in animal studies and in human epidemiological studies. An unexplained observation in several studies was a response which followed a power function of dose with exponent less than one. One explanation offered for this type of response in humans was a postulated population of heterogeneous sensitivity. An alternate, though related, way of considering this question is in terms of multiple-stresses, and this postulate is discussed.

1472 **Mathematical model of a phantom developed for use in calculations of radiation dose to the body and major internal organs of a Japanese adult.** Kerr, G.D. (Oak Ridge National Lab., Tenn. (USA)); Hwang, J.M.L.; Jones, R.M. 17: No. 4, 211-229(Dec 1976).

A mathematical model of a phantom simulating the body and major internal organs of a Japanese adult has been developed for use in computer calculations of radiation dose. The total body height of the mathematical phantom is 162 cm, and the total body mass is 55 kg based on densities of 0.3, 1.4, and 1.0 g/cm^3 for the lung, skeleton, and bulk tissues of the body, respectively.

1473 **Keeping dose commitments ALAP.** Morgan, K.Z. (Georgia Inst. of Tech., Atlanta). pp 71-77 of In Nuclear safety, 1975. Hetrick, D.L. (ed.). Hinsdale, IL; American Nuclear Society (1975).

From ANS topical meeting on nuclear safety; Tucson, Arizona, USA (5 Oct 1975).

See CONF-751044—.

The dose commitment principle should be applied both to the individual and collectively to members of the public and to special subgroups in the population in relation to age, sex, condition of health, etc. It should be applied to each critical body organ in relation to possible somatic injury as well as to the gonads in terms of the genetically significant dose or genetic mutations. The maximum permissible dose commitments cannot and need not be set

essentially at zero but they must be carefully selected such that they do not exceed values that knowledgeable and representable members of the public consider to be as low as practicable (ALAP) and that are believed to be as low as reasonably attainable (ALARA) after giving due and realistic consideration to the various alternatives.

VERTEBRATES

1474 (BNWL—2100(Pt.1), pp 232-233) **Use of molecular hydribization techniques to investigate radiation-induced malignancies.** Frazier, M.E.; Akiya, F. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

A virus has been isolated from miniature swine with radiation-induced leukemia. In order to determine the role of this agent in the oncogenic process hybridization studies must be carried out to determine the nature of this virus. To facilitate these studies DNA from a variety of sources has been purified and tested. A number of available RNA tumor viruses have been produced or procured in amounts sufficient to allow preparation of DNA probes and purification of RNA.

1475 **Pathogenesis of radiation injury in the neonatal canine kidney.** Eisenbrandt, D.L. Fort Collins, CO; Colorado State Univ. (1976). 203p. University Microfilms Order No. 77-12,033.

Thesis (Ph. D.).

An investigation was made of the normal postnatal development of the canine kidney and the effects of neonatal irradiation on that development. Beagles were irradiated with 330R ^{60}Co gamma radiation on the second postnatal day of life. Sequential sacrifices at 2 days (6 hours after irradiation), 4, 8, 14, 22, 70, and 200 days of age permitted the determination of the mechanisms and pathogenesis of the radiation injury. The kidneys were evaluated with qualitative and quantitative histologic methods. Scanning electron microscopy was employed to determine the surface characteristics of the developing glomeruli. The presence of a subcapsular nephrogenic zone in the kidneys of the dogs until 8 to 10 days of age was the basis for the marked radiosensitivity of the neonatal canine kidney. This zone contained interactive tissues which produced new nephrons. Several developmental stages of forming nephrons were identified within this zone. Beneath the nephrogenic zone, corpuscles of greater maturity were located at successively deeper cortical levels. Juxtamedullary corpuscles resembled those of adult animals. The complex differentiation of the podocytic cytoplasmic processes in the developing glomeruli was studied with scanning electron microscopy. The total number of nephrons in the normal dogs was estimated to be approximately 445,000 per kidney. This number did not vary significantly between 14 and 200 days of age. Three mechanisms of radiation injury were identified. First, extensive mitotic-linked cell death occurred in the nephrogenic zone. Second, mitotic delay resulted in only one-fifth of the normal mitotic activity in the nephrogenic zone through 2 days post-irradiation. Third, an immediate and permanent cessation of the induction of new nephrons occurred.

1476 **Dose-response relationships for postirradiation erythrocyte levels.** Bainter, H.T. Fort Collins, CO; Colorado State Univ. (1976). 293p. University Microfilms Order No. 77-12,022.

Thesis (Ph. D.).

The responses of the circulating erythrocyte levels in beagles, as measured by the hematocrits, following exposures to ^{60}Co radiations were studied. Quantitative dose-response relationships were determined on a short-term basis following acute exposures to male adult beagles. Quantitative dose-response relationships were determined on a long-term basis following acute exposures to male and female beagles in utero at 8 days postcoitus (dpc), 28 dpc and 55 dpc, and to male and female beagles at 2 days postpartum (dpp), 70 dpp and 365 dpp. For the short-term responses, the response was quantified by two different methods. One method used the average deviation of the postirradiation hematocrit from the preirradiation value as a response. The response of average deviation was shown to be dose dependent and the dose-response relationship was shown to be modified as a result of previous irradiations. The other method involved describing the time dependent change in the postirradiation hematocrit with two nonlinear mathematical models. The estimated parameters of the nonlinear model that best described the time dependent change were then treated as response variables. Linear model analysis techniques were used to investigate and demonstrate the existence of quantitative dose-response relationships for these estimated parameters. The estimated parameters were also shown to be dependent on previous irradiation. In the case of the long-term responses, linear models were formulated to account for variation due to sex, age, month of observation and calendar year of observation. Statistically significant dose-response relationships were shown to exist at one year of age for male beagles irradiated at 55 dpc and for female beagles irradiated at 8 dpc and 70 dpp. Statistically significant dose-response relationships were shown to exist at two years of age for male beagles irradiated at 55 dpc, 2 ddp and 365 dpp, and for female beagles irradiated at 365 dpp.

1477 **Effects of x-irradiation on cat cerebelli at different postnatal intervals. An anatomical analysis.** Anderson, W.J. Lafayette, IN; Purdue Univ. (1975). 141p. University Microfilms Order No. 76-7025.

Thesis (Ph. D.).

The investigation was designed to study the postnatal development of the cerebellum in the cat with the aid of low-level x-irradiation, and to determine the behavioral and anatomical abnormalities which might result from such exposure. Wholehead fractionated irradiation doses of 200R and 150R were utilized. Low-level x-irradiation was initiated in five experimental age groups. Irradiation was begun at birth, 1-week, 2-weeks, 3-weeks and 4-weeks and was continued over a period of 14 or 20 days to prevent reconstitution of proliferating cells. Animals irradiated at birth displayed minor deficits in behavior, which included ataxia, tremor, hypertonus and dysmetria, while animals irradiated at one week showed only mild symptoms of hypermetria. Animals irradiated at birth had smaller eyes and ears, a reduction in the entire head, and were susceptible to seizures. At 70 days of age, all animals including a control group were sacrificed and the cerebellums underwent routine histological processing or were prepared for Golgi analysis. The cerebellum was found to be reduced in size and weight, the greatest deficit being seen in animals whose cerebellum was x-irradiated at the early ages. Total granule cell deficits were found to range from 83% at birth to 29% at 4 weeks. Cerebellar changes for the molecular layer, internal granular layer, medullary layer, Purkinje cell to granule cell ratio, and granule cell density, all depicted the greatest changes in the earlier ages that x-irradiation was begun.

RADIONUCLIDE EFFECTS - INTERNAL SOURCE

MAN

REFER ALSO TO CITATION(S) 1373

1478 (BNWL—2100(Pt.1), pp 223-225) **Progress in developing a portable blood irradiator for medical applications.** Hungate, F.P.; Bunnell, L.R.; Riemath, W.F. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

This year was spent in perfecting details of the new design blood irradiator, i.e., having male fittings made for shunt insertion and in acquiring preliminary biological data on its effectiveness. Fabrication of units was slowed by an unanticipated reaction of the resin with the steel injection mold, by occasional thrombogenic flaws in the blood interface layer, by thrombus formation at the points of connection to the shunt and by nonavailability of a reactor for activating the ^{169}Tm to ^{170}Tm. The remaining unsolved problem is that of thrombus formation at the connectors.

ANIMALS

REFER ALSO TO CITATION(S) 1499

1479 (BNWL—2100(Pt.1), pp 17-21) **Dose-effect studies with inhaled plutonium oxide in beagles.** Park, J.F.; Buschbom, R.L.; Case, A.C. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical Sciences.

Beagle dogs given a single exposure to $^{239}PuO_2$ or $^{238}PuO_2$ aerosols are being observed for life-span dose-effect relationships. The ^{239}Pu body burden of the nine dogs that died of pulmonary fibrosis-induced respiratory insufficiency during the first 3 yr after exposure was 1 to 12 μCi. One of these dogs had a pulmonary tumor. Five additional dogs with body burdens of 0.7 to 1.8 μCi died due to pulmonary neoplasia 3 to 5 yr after exposure. None of the dogs exposed to ^{238}Pu have died during the first 3 postexposure yr. Lymphocytopenia was the earliest observed effect after inhalation of $^{239}PuO_2$ or $^{238}PuO_2$, occurring 0.5 to 2 yr after deposition of greater than or equal to 80 nCi plutonium in the lungs.

1480 (BNWL—2100(Pt.1), pp 25-27) **Inhaled plutonium nitrate in dogs.** Dagle, G.E.; Cannon, W.C.; Ragan, H.A.; Watson, C.R.; Stevens, D.L.; Cross, F.T.; Dionne, P.J.; Harrington, T.P. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical Sciences.

Beagle dogs given a single inhalation exposure to $^{239}Pu(NO_3)_4$ are being observed for life-span dose-effect relationships. Over half of the dogs planned for $^{239}Pu(NO_3)_4$ exposure have been exposed and the remaining dogs will be exposed as they reach adult age.

1481 (BNWL—2100(Pt.1), pp 31-32) **Role of protracted exposure on the toxicology of inhaled $^{239}PuO_2$.** Sanders, C.L. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical Sciences.

Studies were initiated to examine in rats the effects of a protracted exposure to inhaled $^{239}PuO_2$. Graphs are presented to show effect of multiple exposures to $^{239}PuO_2$ on the deposition and clearance of ^{239}Pu in the alveoli.

1482 (BNWL—2100(Pt.1), pp 33-35) **Cocarcionogenesis of inhaled plutonium dioxide and beryllium oxide.** Sanders, C.L.; Powers, G.J. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical Sciences.

Inhaled beryllium oxide results in impaired alveolar clearance of inhaled $^{239}PuO_2$ and induces an inflammatory reaction in the lung. However, only one of 184 rats exposed to beryllium developed a lung tumor; none of 128 unexposed rats developed a lung tumor. Fifty-six lung tumors were induced in 181 rats exposed to plutonium. A total of 37 lung tumors were found in 119 rats given combined exposures to beryllium and plutonium. Only in rats given the highest levels of both beryllium and plutonium was there an incidence of lung tumors greater than that seen with exposure to plutonium only.

1483 (BNWL—2100(Pt.1), pp 35-37) **Late effects of inhaled $Pu(NO_3)_4$ in rats.** Ballou, J.E.; Dagle, G.E.; McDonald, K.E. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical Sciences.

Rats that inhaled $^{239}Pu(NO_3)_4$ or $^{238}Pu(NO_3)_4$ developed lung tumors and bone tumors. Lung tumors were clearly associated with Pu inhalation (accumulated dose to lung, 1 rad to 5000 rads); bone tumors could not be unequivocally related to the radiation insult.

1484 (BNWL—2100(Pt.1), pp 40-42) **Quantative autoradiography of inhaled $^{239}PuO_2$ in the lung.** Rhoads, K.; Moon, D.; Sanders, C.L. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical Sciences.

PuO_2 particles behaved similarly in the lungs of rat and hamster. The relative concentrations of PuO_2 up to 1-yr postexposure were 1.0 for lung parenchyma, 1.3 for subpleural areas, 0.5 for peribronchiolar regions and 0.2 for perivascular regions in the lungs.

1485 (BNWL—2100(Pt.1), pp 49-52) **Carcinogenesis of inhaled radio daughters with uranium ore dust in beagle dogs.** Filipy, R.E.; Dagle, G.E.; Palmer, R.F.; Stuart, B.O. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical Sciences.

Daily exposures of adult beagle dogs to inhaled radon daughters and to uranium ore dust for 4-1/2 to 6 yr have produced respiratory tract carcinomas, at similar cumulative working level months (WLM) of exposures to those which induced carcinomas in uranium miners. Biological data from the beagle-dog experiments can therefore be used for prediction of carcinogenic risk under changing exposure conditions in future uranium miners.

1486 (BNWL—2100(Pt.1), pp 52-55) **Non-neoplastic pulmonary disease from inhaled radon daughters with uranium ore dust in beagle dogs.** Filipy, R.E.; Palmer, R.F.; Stuart, B.O. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical Sciences.

Daily exposures of adult beagle dogs to inhaled radon daughters plus uranium ore dust, with and without concurrent cigarette smoking, for 2 to 5-1/2 yr have produced massive pulmonary fibrosis and severe emphysema. The cumulative exposure doses are similar to those associated with a 5-fold or greater increase in death rate of uranium miners due to chronic respiratory insufficiency, including pneumoconiosis, pulmonary fibrosis, and emphysema.

1487 (BNWL—2100(Pt.1), pp 56-60) **Comparative toxicity in rats vs hamsters of inhaled radon daughters with and without uranium ore dust.** Gaven, J.C.; Palmer, R.F.; McDonald, K.E.; Lund, J.E.; Stuart, B.O. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical Sciences.

Simultaneous exposures of rats and hamsters to inhaled radon daughters, with and without uranium ore dust, were performed daily for five months. Pulmonary pathology developing in 6 to 13 mo after cessation of daily exposures included interstitial fibrosis, emphysema, epithelial hyperplasia, squamous metaplasia, and malignant neoplasia. Rats showed a greater variety and more severe response to these uranium mine inhalation exposures than did hamsters. Inhalation of radon daughters with uranium ore dust displayed the site of greatest damage, including squamous carcinoma, from the nasopharynx to the lungs. Sixty percent of the rats exposed to radon daughters with ore dust developed primary pulmonary carcinomas, providing an appropriate short-term experimental animal model for investigation of respiratory tract carcinogenesis in uranium miners.

1488 (BNWL—2100(Pt.1), pp 101-103) **Effects of ^{239}Pu administered 9 days of gestation on hematologic development of the rat.** Joshima, H.; Hackett, P.L.; Kujawa, M.J.; Doctor, P.G.; Sikov, M.R. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

Injection of pregnant rats with monomeric ^{239}Pu after 9 days of gestation decreased their leukocyte and reticulocyte counts at 5 and 10 days postexposure. Most of the fetal hematologic enumerative values were unaffected by injection of monomeric ^{239}Pu. There was, however, a major change in the maturation of the cells of the erythroid series, as indicated by a difference in the distribution between cell types. The weight of the yolk sac and fetal liver, and the cellularity of the fetal spleen were decreased.

1489 (BNWL—2100(Pt.1), pp 104-105) **Strain differences in the embryotoxicity of ^{239}Pu.** Sikov, M.R.; Mahlum, D.D.; Andrew, F.D. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

Comparison of the embryolethality of monomeric ^{239}Pu injected at 9 days of gestation demonstrated that the sensitivity of Charles River CD strain was greater than that of Hilltop Wistar rats. Subsequent comparisons showed that rats derived from the Hilltop Fischer strain were more sensitive than the Wistar and, although not directly compared, more sensitive than the CD.

1490 (BNWL—2100(Pt.1), pp 108-109) **Late effects of ^{239}Pu administered at representative stages of gestation.** Andrew, F.D.; Sikov, M.R. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

The protocol for a systematic comprehensive study of the influence of prenatal exposure on the tumorigenic and other adverse effects of ^{239}Pu is described. The study has been initiated, all animals have been weaned, and postnatal function is being evaluated, although results are not yet available.

1491 (BNWL—2100(Pt.1), pp 133-136) **Prevention of death from ingested ruthenium-106 by colectomy.** Sullivan, M.F.; Beamer, J.L.; Karagianes, M.T. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

Two dogs were given 3.0 mCi/kg body weight of ^{106}Ru-^{106}Rh and two were given 4.0 mCi/kg. At 5 days after treatment, one dog from each dose level was colectomized. The dog given the larger dose but not surgically treated was killed in extremis due to acute lower bowel injury at 18 days. The other dog, given 3.0 mCi/kg but not surgically treated, was killed in a moribund condition at 145 days after dosing. The rectum had perforated. The colectomized dogs recovered from intestinal injury and showed no radiation damage at the termination of the study.

1492 (BNWL—2100(Pt.1), pp 143-144) **Common tumors and lesions in control miniature swine fed ^{90}Sr daily.** Ragan, H.A.; Lund, J.E. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

Control miniature swine, averaging 9 yr of age had an approximately 45% incidence of benign tumors and 11% incidence of malignant tumors. Swine of comparable age, fed 1 or 5 μCi ^{90}Sr for their lifetime, had a similar incidence of benign tumors, but about a two-fold increase in malignant neoplasms. The occurrence of non-neoplastic lesions was similar in the three groups.

1493 (BNWL—2100(Pt.1), pp 229-230) **Culture of cells from beagles with bronchioloalveolar carcinoma.** Frazier, M.E.; Andrews, T.K. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

Cell cultures were prepared from lung tumors occurring in beagles following exposure to inhaled plutonium. Morphologic and growth characteristics of two of these cell lines are described.

1494 (BNWL—2100(Pt.1), pp 238-239) **Differentiation of peripheral lymphocyte population in Pu-exposed beagle dogs.** Morris, J.E. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

The percentage of peripheral lymphocytes binding fluorescent-labeled anticanine antibodies was measured in plutonium-oxide-exposed and unexposed beagle dogs. With this assay system, there was a significant decrease in the percentage of lymphocytes binding the labeled antibody in exposed animals compared to control animals.

1495 (BNWL—2100(Pt.1), pp 240-241) **Hematologic effects of $^{239}PuO_2$ in rats.** Ragan, H.A. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

Rats exposed to approximately 200 nCi deep lung deposition of $^{239}PuO_2$ developed a mild, transient lymphopenia 4 weeks later. A trend to concurrent neutrophilia was evident along with a significant increase in lung weights.

1496 (BNWL—2100(Pt.1), pp 241-242) **Improved gradient for isolation of dog lymphocytes and subsequent quantitation of T-cell rosettes.** Ragan, H.A. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

Preparation of an improved density gradient for isolation of dog lymphocytes is discussed. About 68% of the lymphocytes from a sample of blood were recovered using this gradient, compared to approximately 50% recovery from the gradient used previously. Cytochemical staining indicated the gradient does not selectively remove a subpopulation of lymphocytes. A greater percent of lymphocytes capable of forming E rosettes with human blood was found in plutonium-exposed than in control dogs.

1497 (ORO—3728-10) **Mutagenic effect of radionuclides incorporated into DNA of drosphila melanogaster. Progress report, 1976—1977.** Lee, W.R. 1977. Contract EY-76-S-05-3728. 8p. Dep. NTIS, PC A02/MF A01.

Progress is reported on studies of the genetic effect of tritium incorporated into DNA of Drosophila melanogaster. Following a short pulse exposure to tritium-labeled uridine most of the radioactivity appeared in RNA; however, the turnover of radioactivity in tritium-labeled RNA was rapid whereas there was no exchange of tritium from the labeled DNA during spermatogenesis. Furthermore, most of the cytoplasm and most of the RNA in primary spermatocytes was lost during spermatogenesis and thus the mature sperm cell was left with only the DNA labeled. Preliminary experiments did not show a significant level of labeled RNA remaining in the mature sperm cell, whereas labeled DNA was verified after extraction and purification with phenol and enzyme digestion. Preliminary results of genetic tests on the progeny of normal females inseminated with tritium-labeled sperm cells are reported.

PLANTS

1498 **Mitotic activity and cell population kinetics in pisum root meristems during and after treatment with high concentrations of tritiated—thymidine.** Stetka, D.G. Jr. Amherst, MA; Univ. of Massachusetts (1975). 104p. University Microfilms Order No. 76-5295. Thesis (Ph. D.).

The effects of ^{3}H-thymidine on cell progression through the mitotic cycle and on cell population kinetics both during and after exposure have been investigated. During exposure there is an accumulation of cells in G2 while the proportions of cells in G1, S and M decrease. Quiescent center cells are induced to synthesize DNA and presumably divide following inhibition of mitosis in the surrounding meristem, accounting in part for a transient increase in mitotic activity. Mitotic activity eventually ceases, however, so metistems are unable to recover from radiation damage during continuous treatment with ^{3}H-thymidine. Meristems recover from ^{3}H-thymidine induced reduction in mitotic activity when the roots are no longer exposed to exogenous ^{3}H-thymidine. Those cells which accumulate in G2 during ^{3}H-thymidine treatment do not retain the capacity to divide, while cells remaining in G1 and S do divide following treatment and thereby account for recovery. Cytoplasmic irradiation from unincorporated ^{3}H-thymidine and ^{14}C-thymidine apparently prevents recovery from inhibition of cell progression through the mitotic cycle which itself is due to nuclear irradiation from incorporated ^{3}H-thymidine and ^{14}C-thymidine apparently prevents recovery from inhibition of cell progression through the mitotic cycle which itself is due to nuclear irradiation from incorporated ^{3}H-thymidine. Unincorporated ^{3}H-thymidine also prevents recovery from sucrose deprivation in stationary phase G2 cells, indicating that G2 is the most radiosensitive stage in the mitotic cycle under the present conditions and that unincorporated isotopes alone may affect cell progression through the mitotic cycle.

NUCLIDE KINETICS AND TOXICOLOGY

ANIMALS

1499 (BNWL—2100(Pt.1)) **Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical Sciences.** Thompson, R.C. May 1977. Contract EY-76-C-06-1830. 292p. Dep. NTIS, PC A13/MF A01.

Separate abstracts were prepared for individual sections of this publication. In addition to research reports the publication also contains organization charts, author index, and appendixes showing data on selected parameters relative to life-span dose-effect studies with inhaled $^{239}PuO_2$, $^{238}PuO_2$, and ^{239}Pu in beagles. (HLW)

1500 (BNWL—2100(Pt.1), pp 3-4) **Deposition of inhaled aerosols in beagle dogs.** Cannon, W.C.; Craig, D.K.; Herring, J.P.; Powers, G.J. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical Sciences.

Additional measurements have been made of deposition and retention of inhaled radioactively labeled iron oxide aerosols generated by a spinning top aerosol generator.

1501 (BNWL—2100(Pt.1), pp 38-39) **Early fate of inhaled crystalline $^{239}Pu(NO_3)_4$ in rats.** Ballou, J.E.; Gies, R.A.; Ryan, J.L. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical Sciences.

Preliminary results suggest that $Pu(NO_3)_4$ inhaled as crystalline solid aerosol is retained more tenaciously in the lung and excreted less in urine than inhaled $Pu(NO_3)_4$ aerosols generated from a nitric acid solution.

1502 (BNWL—2100(Pt.1), pp 45-46) **$^{239}PuO_2$ aerosol exposure of miniature swine.** Karagianes, M.T.; Beamer, J.L.; Craig, D.K.; Kaune, W.T.; Decker, J.E; Cannon, W.C. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical Sciences.

Techniques were developed for intranasal exposure of miniature swine to radioactive aerosols. Distribution, retention and excretion data are reported for four swine exposed to inhaled $^{239}PuO_2$.

1503 (BNWL—2100(Pt.1), pp 73-77) **Accumulation and distribution of ^{85}Kr in rats exposed to ^{85}Kr atmospheres.** Willard, D.H.; Ballou, J.E. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical Sciences.

Retention kinetics and tissue partition coefficients for ^{85}Kr were determined in rats exposed to known concentrations of ^{85}Kr gas. The tissue partition coefficients were used to calculate the relative tissue radiation dose, assuming exposure conditions equivalent to the maximum permissible concentration in air (MPC)a. The estimated radiation dose was highest in adrenals and body fat, about twice the dose estimated for the next highest tissue, ovaries. Saturation and desaturation curves show that the contents of the large intestines have a prolonged desaturation time compared to other samples analyzed.

1504 (BNWL—2100(Pt.1), pp 78-79) **Retention of ^{85}Kr in the rat and beagle dog.** Willard, D.H.; Ballou, J.E. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical Sciences.

Rats and dogs exposed to ^{85}Kr atmospheres retained ^{85}Kr with similar retention kinetics. Retention in both species could be described by two exponential functions: a short-lived component with half-life of 5-7 min, accounting for 40-45% of the activity; and a longer-lived component with half-life of 40-60 min, accounting for 55-60%. Administration of a tranquilizing drug, acetylpromazine, did not alter relative ^{85}Kr retention as a function of time in the beagle dog; however, total retention was decreased to about 1/20th the expected value, probably because of depressed respiratory function.

1505 (BNWL—2100(Pt.1), pp 80-81) **Disposition of ^{85}Kr in gravid rats.** Andrew, F.D.; Sikov, M.R.; Willard, D.H. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical Sciences.

Pregnant rats were exposed to ^{85}Kr for 4-6 hr and sacrificed immediately thereafter. The ^{85}Kr concentration in the fetoplacental

unit (FPU) was approximately the same at all gestation stages for intact FPU, isolated fetuses or fetal segments, as well as placentas and associated membranes. Maternal tissue concentrations varied over a wide range and only liver and intestine concentrations were relatively similar in both 20-day-gestation (dg) fetuses and adults.

1506 (BNWL—2100(Pt.1), pp 82-83) **Preliminary studies in sheep exposed to ^{85}Kr atmospheres.** Andrew, F.D.; Willard, D.H.; Ballou, J.E.; Sikov, M.R. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical Sciences.

Accumulation of ^{85}Kr in arterial blood of sheep occurs within 10 min of inhalation exposure initiation, and disappears by 30 min after exposure termination. As reported for other species, ^{85}Kr concentrations in fat were approximately 10 times those in other tissues.

1507 (BNWL—2100(Pt.1), pp 91-93) **Early disposition of inhaled uranyl nitrate (^{232}U and ^{233}U) in rats.** Ballou, J.E.; Gies, R.A. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical Sciences.

Uranyl nitrate (^{233}U) was retained mainly in lung, skeleton, pelt and kidney 60 days after inhalation exposure. The concentration in lung exceeded that in other tissues. Preliminary results with ^{232}U indicate retention in lung similar to that of ^{233}U, at total deposited mass levels of 0.1 μg or less.

1508 (BNWL—2100(Pt.1), pp 94-95) **Long-term effects of inhaled uranyl nitrate in rats.** Ballou, J.E.; Gies, R.A.; Ryan, J.L. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical Sciences.

Rats were exposed to aerosols of ^{233}U and ^{232}U nitrate in a study of the long-term biological effects. Preliminary radiation dose estimates show lung > skeleton > kidney in each dose group.

1509 (BNWL—2100(Pt.1), pp 95-97) **Nondestructive analysis for ^{232}U and decay progeny in animal tissues.** Ballou, J.E.; Wogman, N.A. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

Direct determination of ^{232}U and its decay products in animal tissues appears to be feasible using an intrinsic Ge(Li) diode detector (for energies of 5-100 keV) and a NaI(Tl) anticoincidence-shielded Ge(Li) diode for higher-energy gamma photons. The detection sensitivity for ^{232}U and ^{228}Th is 0.03 and 0.01 nCi, respectively, using a 300-min counting time.

1510 (BNWL—2100(Pt.1), pp 105-107) **Mobilization of plutonium burdens during pregnancy.** Hackett, P.L.; Mahlum, D.D.; Sikov, M.R. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

The mobilization and distribution of previously deposited ^{239}Pu was compared in pregnant rats (15 and 20 days of gestation) and nonpregnant controls. Pregnancy had little effect on ^{239}Pu tissue burdens and only minimal activity appeared in the fetoplacental unit. Marked differences were observed in tracer ^{45}Ca deposition patterns between the experimental groups.

1511 (BNWL—2100(Pt.1), pp 112-113) **Deposition and retention of inhaled $^{239}PuO_2$ aerosols in new born and adult rats.** Sikov, M.R.; Cannon, W.C.; Buschbom, R.L.; Mahlum, D.D. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

Adult and newborn rats were exposed to $^{239}PuO_2$ aerosols of four different size distributions. Rats of both ages were killed at intervals between 1 hr and 60 days postexposure. There were marked age- and particle-related size differences in deposition, although retention was similar throughout. The differences in deposition are attributable to relatively greater deposition of larger particles in the upper respiratory tracts of newborns.

1512 (BNWL—2100(Pt.1), pp 117-118) **Absorption of plutonium in the iron-deficient rat.** Ragan, H.A. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

Iron deficiency did not enhance absorption of plutonium following intragastric gavage of rats. Absorption of plutonium citrate in both control and iron-deficient rats was about 0.03% of the administered dose.

1513 (BNWL—2100(Pt.1), pp 123-125) **Gastrointestinal absorption of transuranic elements by rats.** Sullivan, M.F. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

Absorption of "organically bound" ^{233}U and ^{241}Am from gastrointestinal tracts of adult rats was twice that of the inorganic nitrate form. There was no difference between transport of ^{232}U and ^{233}U by adult rats, but ^{232}U absorption by newborn rats was four times that of ^{233}U. Absorption of ^{238}Pu nitrate through the gut of the newborn is relatively insensitive to dose but incorporation in the gut mucosa saturates at high dose levels. Absorption of ^{238}Pu is greater at 4 hr of age than at 24 hr.

1514 (BNWL—2100(Pt.1), pp 126-129) **Gastrointestinal absorption of radionuclides by the neonatal rat, guinea pig and swine.** Sullivan, M.F. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

Ruthenium-106 administered to newborn rats and swine was incorporated into the epithelium of the lower small intestine and retained there for a few weeks after gavage; the stomach and small bowel of guinea pigs incorporated ^{106}Ru but did not retain it.

1515 (BNWL—2100(Pt.1), pp 137-139) **Gastrointestinal absorption of alfalfa-bound plutonium-238 by rats and guinea pigs.** Sullivan, M.F.; Garland, T.R. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

Rats and guinea pigs were fed ^{238}Pu either biologically incorporated into alfalfa (by growth of the plant on soil containing Pu) or added as a solution to alfalfa, or were gavaged with a Pu solution. Depending upon the plant material fed, there appeared to be a twofold increase in ^{238}Pu-gut absorption by the rat and a two- to fourfold increase in the guinea pig as compared with absorption from the Pu solution. The data, though limited and variable, suggest that Pu bound to plant tissue may have higher gut absorptivity than inorganic Pu in both herbivorous and nonherbivorous rodents.

1516 (BNWL—2100(Pt.1), pp 201-204) **In vitro study of plutonium in macrophages.** Schneider, R.P.; Robinson, A.V. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

An in vitro system for studying Pu uptake by, and removal from, macrophages was developed to provide data for the actinide therapy program. We have shown that $^{239}PuO_2$ particle uptake in vitro resembles the process in vivo with respect to the intracellular localization of phagocytized particles. At the end of 7 days of culture of Pu-loaded cells, 54% of the cells were viable even though 71% of the cells in the culture initially contained enough $^{239}PuO_2$ to deliver more than 53 intracellular α-disintegrations.

1517 (BNWL—2100(Pt.1), pp 205-208) **Mass effect and Pu removal from rats with Ca- or Zn-DTPA.** Smith, V.H. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

Eight percent of an intramuscular injection of 27.6 nCi of $^{237}Pu(NO_3)_4$ was retained by rats at the injection site, after 22 days. More than 30% is usually retained following injection of more massive quantities of ^{239}Pu. Treatment with Ca- or Zn-DTPA showed the former to be more effective when treatments were initiated 1 hr after Pu administration. When treatments were begun 7 days after the Pu injection, 416 nmol Ca-DTPA/kg was more effective in removing Pu than 28.7 nmol/kg (human dose level) of Zn- or Ca-DTPA. Due to its high specific activity and ease of detection, ^{237}Pu permits facile experimentation in small animals at Pu mass levels comparable to those encountered in most human exposures.

1518 (BNWL—2100(Pt.1), pp 209-210) **Experiments toward medical management of radionuclides in the gut: effect of deferoxamine on $^{238}Pu(NO_3)_4$ absorption from rat gut.** Smith, V.H. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

Deferoxamine (DFA) (250 mg/kg), orally administered to rats, decreased Pu absorption from orally administered $^{238}Pu(NO_3)_4$ by about 1/3. The calcium salt of diethylenetriaminepentaacetic acid (Ca-DTPA), given orally 5 to 10 min after the Pu, increased absorption about four times. DFA given 10 min before the DTPA decreased the effect of the latter by a factor of two. Deferoxamine administration prior to inhalation treatment of man with DTPA may be one way to decrease possible DTPA-enhanced gut absorption of Pu.

1519 (BNWL—2100(Pt.1), pp 211-212) **Removal of ^{239}Pu from the rat with an orally administered chelon.** Smith, V.H. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

The oral administration of 2,3-dihydroxybenzoic acid (DHB) to rats injected intravenously 1 hr previously with ^{239}Pu citrate caused an increase in urinary excretion of Pu about 8 times that of animals treated with 0.9% NaCl (controls). Liver retention of Pu was decreased from 18% at 2 days in the control animals to 11% in DHB-treated rats. The skeletal retention was similarly reduced from 56% in the control group to 40% in the DHB-treated animals.

THERMAL EFFECTS

PLANTS

1520 Effects of emersion and temperature upon growth of the tropical brown alga Padina japonica, using a tide-sumulation apparatus. Allender, B.M. (Univ. of Hawaii, Honolulu). **40**: No. 2, 95-99(1977).

A simple tide-simulation apparatus was used to investigate the influence of emersion and temperature on the intertidal growth of Padina japonica Yamada in both the juvenile and adult growth phases. The upper zonation limits are not determined by the sensitivity of any particular growth phase, since all phases show the same emersion tolerance limits. The species grows best when continuously submerged, and growth rates decrease with increasing emersion up to a clear upper zonation boundary. High temperature reduces the emersion tolerance and is therefore an important factor in tropical intertidal zonation.

INVERTEBRATES

1521 Acute temperature and low dissolved oxygen tolerances of brachyuran crab (Cancer irroratus) larvae. Vargo, S.L.; Sastry, A.N. (Univ. of Rhode Island, Kingston). **40**: No. 2, 165-171(1977).

Tolerance limits to acute temperature, and temperature and low dissolved oxygen stresses were determined for 5 zoeal stages and megalops of Cancer irroratus Say. The acute temperature limits for a 120 min exposure were all approximately 29.0°C, with little interstage variation, while those for 240 min exposure ranged from 27.3° to 28.5°C. More interstage variation was shown when temperature and low dissolved oxygen stress were combined, with low oxygen tolerance decreasing as temperature increased. The first, second, and fourth zoeal stages display similar patterns of response. The third and fifth stages show a similar response, but are different from the former stages. The megalops is relatively insensitive to changes in oxygen concentration with temperature. The larval stages did not show a progressive increase in tolerance to temperature or low dissolved oxygen with development. Tolerance to these factors may be related to size, stage of development and activity level. The larval stages have capacities to tolerate a wider range of these factors than they require in the natural environment.

1522 Tagging experiments with western king prawn, Penaeus latisulcatus Kishinouye. II. Estimation of population parameters. Penn, J.W. (Dept. of Fisheries and Wildlife, North Beach, Western Australia). **27**: No. 2, 239-250(Jul 1976).

The toggle tagging method previously tested for suitability with adult western king prawns has been used in an intensive field trial in a previously unexploited population of prawns confined in Cockburn Sound, Western Australia. Approximately 12,000 tagged prawns, in three consecutive experiments, were released over a period of 3 months during which time the population was subjected to controlled fishing by a chartered trawler to simulate a commercial fishery. Using the catch-effort data and recaptures from the three releases, a number of methods of estimating population size have been evaluated. The Petersen estimates, selected as most appropriate, have been used to calculate instantaneous rates of natural and fishing mortality, and catchability coefficients during the experimental period. An apparent relationship between catchability and temperature has been discussed together with other biological problems encountered in the use of prawn tag recapture data.

VERTEBRATES

REFER ALSO TO CITATION(S) 1407, 1408

1523 Temperature and photoperiod regulation of rheotropic behavior in prespawning common shiners, Notropis cornutus. Dodson, J.J.; Young, J.C. (Univ. of Waterloo, Ont.). **34**: No. 3, 341-346(Mar 1977).

The upstream orientation and frequency of upstream movement of prespawning common shiners, Notropis cornutus, in response to a water current simulated by moving a striped background past the fish were observed at three temperatures (10, 15, 20°C) and two photoperiods (12L:12D and 16L:8D). The greatest frequency of upstream movement was induced by a combination of spring day lengths and warm water temperatures. Further increases in the frequency of upstream movement followed immediate 5°C increases in water temperature. Neither temperature nor photoperiod had a major effect on the frequency of upstream orientation. The significance of environmental regulation of rheotropism as a mechanism of upstream migration is discussed.

CHEMICALS METABOLISM AND TOXICITY

CELLS

1524 (BNWL—2100(Pt.1), pp 159-161) **Microbial testing of shale oil for potentially carcinogenic materials.** Pelroy, R.A.; Bushaw, V.G.; Petersen, M. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

Raw shale oil and the acidic, basic, polynuclear aromatic (PNA), and tar fractions from shale oil were tested for their mutagenicity against several of the Salmonella typhimurium testor strains of Ames et al., using a modification of their assay system. We identified two highly mutagenic fractions (the basic and PNA fractions) and one weakly mutagenic fraction (the raw shale oil). Other fractions caused little or no increase in the frequency of mutation. We have been unable to demonstrate a requirement for metabolic activation of shale oil. On the other hand, addition of activating enzyme preparations from rat liver (S-9 enzymes) to the assay system consistently led to lower frequencies of mutation. Of all strains tested, S. typhimurium TA-100 is the most sensitive to mutation by the basic and PNA fractions.

1525 (BNWL—2100(Pt.1), pp 177-179) **Effects of cadmium on red blood cell membranes.** Johns, P.T.; Sanders, C.L.; Powers, G.J. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

In vitro pretreating of rat red blood cells with WR-2721 protected them from the increased osmotic fragility and loss of potassium usually caused by incubation with cadmium.

1526 (CONF-770130—3) **Cell transformation and mutability of different genetic loci in mammalian cells by metabolically activated carcinogenic polycylic hydrocarbons.** Huberman, E. 1977. Contract W-7405-ENG-48. 35p. Dep. NTIS, PC A03/MF A01.

From Conference on polycyclic hydrocarbon carcinogenesis; New Orleans, Louisiana, United States of America (USA) (24 Jan 1977).

Treatment of experimental animals with chemical carcinogens, including some polycyclic hydrocarbons, can result in the formation of malignant tumors. The process whereby some chemicals induce malignancy is as yet unknown. However, in a model system using mammalian cells in culture, it was possible to show that the chemical carcinogens induce malignant transformation rather than select for pre-existing tumor cells. In the process of the in vitro cell transformation, the normal cells, which have an oriented pattern of cell growth, a limited life-span in vitro, and are not tumorigenic, are converted into cells that have a hereditary random pattern of cell growth, the ability to grow continuously in culture, and the ability to form tumors in vivo. This stable heritable phenotype of the transformed cells is similar to that of cells derived from spontaneous or experimentally induced tumors. Such stable heritable phenotype changes may arise from alteration in gene expression due to a somatic mutation after interaction of the carcinogen with cellular DNA. In the present experiments we have shown that metabolically activated carcinogenic polycyclic hydrocarbons which have been shown to bind to cellular DNA induce somatic mutations at different genetic loci in mammalian cells and that there is a relationship between the degree of mutant induction and the degree of carcinogenicity of the different hydrocarbons tested.

1527 (LA—6905-PR) **Cytotoxic characterization of "cadmium-resistant" Chinese hamster cells. Progress report, January 1, 1976—June 30, 1977.** Tobey, R.A.; Crissman, H.A.; Kissane, R.J. Aug 1977. Contract W-7405-ENG-36. 7p. Dep. NTIS, PC A02/MF A01.

Survival capacity was determined in various cultures of line CHO Chinese hamster cells treated with cadmium, a representative hazardous trace element released to the environment during fossil fuel processing and combustion. While these cells were extremely sensitive to the cytotoxic effects of cadmium, more resistant populations were obtained by cultivating the cells continuously for 11 wk in medium containing 2×10^{-7} M $CdCl_2$. Resistant populations were not the result of emergence of genetically stable, cadmium-resistant mutants such as those encountered in studies of resistance to aza-

guanine. Rather, they exhibited concentration-dependent survival and a gradual loss of resistance upon cultivation in cadmium-free medium, suggesting that they most likely resulted from cellular phenotypic changes (i.e., an adaptive process). Monolayer-grown cells (37% survival after 11 h of continuous exposure to 10^{-6} M $CdCl_2$) were much more sensitive than suspension-grown cells (37% survival after 43 h) to the cytotoxic effects of cadmium, indicating that the mode of cell cultivation influences cell-survival properties. These findings illustrate the need for detailed base-line studies of the analytical system to be utilized in investigations of trace element effects on cellular metabolism.

MICROORGANISMS

1528 Effects of light, magnesium, and cyanide on accumulation of mercury by a fresh water diatom, Synedra. Fujita, M.; Takabatake, E.; Twasaki, K. (Tokyo Univ.). **16**: No. 2, 164-172(Aug 1976).

The uptake of mercury by Synedra was investigated under several conditions. It was found that the uptake was much higher under illumination than in the dark. The fact that the mercury uptake was stimulated by light together with Mg^{++} suggested that energy-linked metabolism might be responsible for the enhanced uptake of mercury. CN depressed the uptake of mercury by plankton which suggested that the mercury was taken up through a pathway linked to energy metabolism. It was also shown that the uptake observed in the dark or by dead cells was due to passive adsorption. (MU)

PLANTS

REFER ALSO TO CITATION(S) 1382, 1384, 1528

1529 (TID—27691) **Cytological and quantitative cytochemical effects of technetium-99 on plant meristems. Final report, No. 002.** Berlyn, G.P. Jun 1977. Contract EY-76-S-02-4139. 27p. Dep. NTIS, PC A03/MF A01.

The objectives of the present study were to determine: the cytohistological effects of Technetium on the apical meristem of germinating soybeans (Glycine max); the effects of various concentrations of Tc on soybean growth and development in vitro; the effects of a 5 day delay in the exposure of germinating seedlings to Tc; and the effect of added manganese in ameliorating Tc toxicity.

1530 Growth of copper-treated corn roots as affected by EDTA, IAA, succinic acid-2,2-dimethyl hydrazide, vitamins and potassium. Hunter, R.; Welkie, G.W. (Utah State Univ., Logan). **17**: No. 1, 19-26(Apr 1977).

Corn roots were treated for 1 hr in a modified Hoagland's solution containing 8 mg/l Cu^{2+} and either simultaneously or subsequently with various substances, in order to test theories of copper toxicity to roots. Post treatment with IAA, niacin amide, thiamin, or sucrose had no effect on subsequent growth. Addition of excess KCl and succinic acid-2,2-dimethyl hydrazide (an inhibitor of ethylene production) to the copper solution doubled average growth and increased recovery from 27 to 87%. A rinse with EDTA resulted in resumption of normal growth rates and 100% recovery if performed 1 hr after Cu treatment, but this effect was gradually lost in the following 6 to 12 hr. Copper toxicity was increasingly severe as pH of the Cu treating medium increased. Results are not consistent with any theory tested, but they do suggest there is an initial phase of copper-stress which lasts 3 to 6 hr, followed by plant reaction that results in irreversible cessation of growth.

1531 Effects of acid rainfall and heavy metal particulates on a boreal forest ecosystem near the Sudbury smelting region of Canada. Hutchinson, T.C. (Univ. of Toronto); Whitby, L.M. **7**: No. 4, 421-438(Apr 1977).

Sulfur dioxide and particulate pollution have been occurring over a wide area in the Sudbury region, Ontario, as a result of massive smelting operations. Over $3^1/_2$ million short tons of SO_2 were released into the atmosphere in the area in 1972, and this pollutant is now discharged through a 1250-foot smokestack. The particulate contribution is an additional complicating and phytotoxic factor. In 1971, 192 tons of nickel, 145 tons of copper, 1130 tons of iron and 4.5 tons of cobalt per 28 days from two of the smelters were released as airborne pollutants. The natural vegetation of the area is a mixed deciduous boreal forest, with white pine (Pinus strobus), jack pine (Pinus banksiana), red maple (Acer rubrum), red oak (Quercus rubra), etc. as dominant trees. This forest, which previously surrounded the mining town of Sudbury, has been devastated over the past 50 yr, especially by the SO_2 emissions and the increased acidity of rainfall and soils. An area in excess of 100 mi^2 is now almost devoid of vegetation, and damage to the forest vegetation is visible over an area of approximately 1800 mi^2. The increased stack heights to dilute local pollution problems have spread the problem more widely. The pH of rainfall sampled up to 12 mi east of the smallest smelter in 1970 was less than 4.3 and that within 2 mi of the stacks was frequently of less than pH 3.0. Soil erosion has occurred on a large scale. The increased acidity of these soils has increased metal mobility and solubility, presenting phytotoxic problems. The effects on the soil chemistry, especially of organic composition have been profound.

1532 Short-term effects of a simulated acid rain upon the growth and nutrient relations of Pinus strobus, L. Wood, T.; Bormann, F.H. (Yale Univ., New Haven). **7**: No. 4, 479-488(Apr 1977).

Acidified precipitation may affect the productivity of forests by altering the availability of plant nutrients or by affecting the ability of trees to absorb and assimilate those nutrients. In this study, the short-term effects of simulated acid rain (pH range 5.6 to 2.3) upon the growth and nutrient relations of Eastern White Pine seedlings (Pinus strobus, L.) grown in a sandy loam soil were examined. Soil chemistry, soil leachate chemistry, seedling tissue chemistry, and seedling productivity were monitored. Despite increased leaching of cations from the soil, resulting in near depletion of available K^{+1}, Mg^{+2}, and Ca^{+2} at pH 2.3, seedling productivity increased with acidity through the 20-week experimental period. Foliar nitrogen concentrations indicate that fertilization with $NO^{-1}{}_3$, added to the rain as HNO_3, may have caused the growth increase. Implications of cation losses and $NO^{-1}{}_3$ fertilization are discussed.

1533 Acid precipitation and forest vegetation. Tamm, C.O.; Cowling, E.B. (Royal Coll. of Forestry, Stockholm). **7**: No. 4, 503-511(Apr 1977).

Effects of acidic precipitation on forest vegetation may be classified as being either direct or indirect. Among the most important direct effects are damage to protective cuticular layers, interference with normal functioning of guard cells, poisoning of plant cells after diffusion of acidic substances through stomata or cuticle and interference with reproductive processes. Indirect effects include accelerated leaching of substances from foliar organs, increased susceptibility to drought and other environmental stress factors, and alteration of symbiotic associations and host-parasite interactions. The potential importance of nutrient uptake through foliage and the need to understand atmosphere-plant-soil interactions are stressed.

1534 Aerosol deposition on plant leaves. Wedding, J.B. (Colorado State Univ., Fort Collins); Carlson, R.W.; Stukel, J.J.; Bazzaz, F.A. **7**: No. 4, 545-550(Apr 1977).

An aerosol generator and wind tunnel system designed for use in aerosol deposition are described. Gross deposition on rough pubescent leaves was nearly seven times greater than on smooth, waxy leaves. Results suggest that aerosol deposition, on a per unit area basis, for single horizontal streamlining leaves is similar to that for arrays of leaves under similar flow conditions. Wind re-entrainment of $PbCl_2$ particles was negligible while 2.54 cm of simulated rainfall was sufficient to remove 85% of recently applied aerosol.

1535 Detection of trace contaminant effects in aquatic ecosystems. Luoma, S.N. (Geological Survey, Menlo Park, CA). **34**: No. 3, 436-439(Mar 1977).

Populations from polluted areas have been shown to be more resistant to insecticides, copper, nickel, cadmium, lead, and zinc than species from non-polluted areas. If one population of a species is more resistant to a toxicant than are other populations, it is direct evidence that the concentration of the toxicant in the environment of the resistant population is sufficient to elicit biological effects. The presence of a toxicant-resistant population of one species in an ecosystem further suggests that other species may have been affected by the resistance-eliciting substance. (MU)

INVERTEBRATES

REFER ALSO TO CITATION(S) 1394, 1535

1536 Lead levels in small mammals and selected invertebrates associated with highways of different traffic densities. Goldsmith, C.D. Jr.; Scanlon, P.F. (Virginia Polytechnic Inst. and State Univ., Blacksburg). **17**: No. 3, 311-316(Mar 1977).

Lead levels in small mammals were studied in 6 areas—3 associated with highways of different traffic densities, and 3 control sites in forested areas. Lead levels were also studied in insects from 2 traffic areas and in earthworms from different distances from 2 traffic areas. Lead levels were low in insects ranging from 3.84 μg/g to 3.35 μg/g. Lead levels in earthworms were highest in those recovered closest to highways and from the area with the higher traffic volume. Lead levels in mammals generally were highest in mammals from areas of higher traffic densities. Higher levels of lead were found in shrews than in Peromyscus and Microtus.

1537 Acute toxicity of cadmium and zinc to seven invertebrate species from Western Port, Victoria. Ahsanullah, M. (Ministry for Conservation, Melbourne). **27**: No. 2, 187-196(Jul 1976).

The acute toxicity of cadmium and zinc to seven species of invertebrate animals from Western Port was determined using both static and continuous-flow bioassays. In the static bioassays, the species most sensitive to cadmium was Allorchestes compressa,

followed by Mytilus edulis planulatus, Palaemon sp., Neanthes vaali, and Paragrapsus quadridentatus, and the LC_{50} values ranged from 0.2 to 16.7 mg/l. The species most sensitive to zinc was A. compressa, then, in descending order of sensitivity, M. e. planulatus, Neanthes vaali, Palaemon sp., and Paragrapsus quadridentatus, and the LC_{50} values ranged from 0.58 to 13.1 mg/l. Results for two other species, Patiriella exigua and Neotrigonia margaritacea, were inconclusive because of the difficulty in determining the point of death. Continuous-flow bioassays were carried out on Palaemon sp., Paragrapsus quadridentatus, and M. e. planulatus, and in general the LC_{50} values were higher than those in the static bioassays.

VERTEBRATES

REFER ALSO TO CITATION(S) 1499, 1535, 1536

1538 (BNWL—2100(Pt.1), pp 61-63) **Effects of chronic cigarette smoking on platelet functions and coagulation in beagle dogs.** Ragan, H.A. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical Sciences.

Coagulation and platelet function assays were performed in beagle dogs that had smoked ten cigarettes daily for 6 yr. There was no evidence of enhanced coagulation or detectable endproducts of clotting in smoking dogs compared with age-related controls. Platelet reactivity was not increased, either as an acute or chronic effect of smoking, but rather a trend to reduced platelet activity was evident.

1539 (BNWL—2100(Pt.1), pp 67-69) **Daily life-span exposure of rodents to coal dust and diesel engine exhaust.** Palmer, R.F.; Stuart, B.O.; Gaven, J.C. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical Sciences.

Four groups of rats are being exposed to high-CWP bituminous coal dust and/or diesel engine exhaust to study the pathogenesis of pneumoconiosis and pulmonary fibrosis and to correlate lung function changes with pulmonary pathology. The possibility of additional inhalation hazards associated with the proposed use of diesel engines in coal mines is being determined by daily exposure to exhaust from a diesel engine operating under appropriate load-cycling conditions.

1540 (BNWL—2100(Pt.1), pp 87-88) **Exposure of rats to acid aerosols.** Ballou, J.E.; Gies, R.A.; Burton, F.G. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical Sciences.

Rats were exposed to aerosols of nitric acid, hydrochloric acid, and sulfuric acid to determine the long-term biological effects. No effects other than the acutely toxic response to high levels of acid have been observed within 260 days postexposure.

1541 (BNWL—2100(Pt.1), pp 153-155) **Late effects of oil shale pollution.** Lund, J.E.; McDonald, K.E.; Smith, L.G. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

Studies on late effects of oil shale pollutants were initiated during FY 76. Tables list the protocols for investigation of carcinogenic and fibrogenic potential of oil shale particulates. Animals in the long-term study (carcinogenesis) have one remaining intratracheal instillation of particulates to be given and will be observed for an additional 14 months.

1542 (BNWL—2100(Pt.1), pp 169-170) **Effect of intratracheally administered oil shale and spent shale on pulmonary biotransformation enzyme activity.** Gandolfi, A.J.; Shields, C.A. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

Rats were dosed intratracheally with suspensions of oil shale, spent shale, or methylcholanthrene/iron oxide. The activities of some important biotransformation enzymes in the lungs and liver were measured to determine any enzyme inductions. None were found.

1543 (BNWL—2100(Pt.1), pp 171-172) **Absorption of benzo-α-pyrene from intratracheally administered spent shale.** Gandolfi, A.J.; Shields, C.A. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

Tritiated benzo-α-pyrene was adsorbed onto spent shale particles at realistic processing levels. The rate of elution of this ^{3}H-benzo-α-pyrene from the spent shale was determined in vivo and in vitro.

1544 (BNWL—2100(Pt.1), pp 175-176) **Early fate and acute mortality from inhaled cadmium monoxide.** Sanders, C.L.; Adee, R.R.; Powers, G.J. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

Severe pulmonary effects resulted from inhalation of cadium monoxide by rats, possibly due to the rapid solubilization of cadmium monoxide and binding of cadmium to membrane sulfhydryl groups.

1545 (BNWL—2100(Pt.1), pp 180-183) **Early fate of inhaled lead monoxide.** Sanders, C.L.; Adee, R.R. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

Inhaled lead monoxide is soluble in the lungs of rats, the particles being phagocytized by macrophages and Type I alveolar epithelium prior to their dissolution. It is also cytotoxic.

1546 (BNWL—2100(Pt.1), pp 193-195) **Effect of pharmacologic blockade on pulmonary function in awake guinea pigs.** Loscutoff, S.M. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

In preliminary experiments, pulmonary function and cardiac functions were monitored in control guinea pigs and in animals injected with specific inhibitors of histamine, prostaglandins, acetyl choline and catecholamines (β-receptors). Tidal volume, minute volume and respiration rate were not significantly different between control and blocked animals. Pulmonary resistance was significantly higher in animals treated with antihistamines and antiprostaglandins. Pulmonary compliance was significantly lower in animals treated with antihistamines and heart rate was significantly lower in animals treated with β-blockers. Results of these studies will be used in establishing conditions for sulfuric acid aerosol exposures. To avoid confusion between sulfuric acid and drug-related effects, concentrations of sulfuric acid will be used which produce changes in pulmonary resistance and compliance significantly greater than changes caused by administration of drugs.

1547 (BNWL—2100(Pt.1), pp 261-262) **Cross-placenta transfer and embryotoxicity of lead in rats.** Hackett, P.L.; Sikov, M.R. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

The kinetics of lead distribution in the fetoplacental unit was studied during the 30-hr period following intravenous administration of 0, 5, and 25 mg $Pb(NO_3)_2$/kg to pregnant rats at 9 and 15 days of gestation. Subsequent evaluation of 20-day fetuses showed that the highest dose level produced teratisms or mortality, depending on the time of administration.

1548 (BNWL—2100(Pt.1), pp 263-265) **Lead toxicity in pregnant rats.** Hackett, P.L.; Sikov, M.R. May 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 1. Biomedical sciences.

Lead in pregnant rats was rapidly cleared from blood with immediate uptake into major organ systems (skeleton, kidney, and liver). This was accompanied by early hemolysis and hematuria as well as gross kidney damage and hemorrhage of the gastrointestinal tract. Skeletal content increased over an 11-day period, during which time about 90% of the lead was removed from kidneys and liver. Distribution and retention were affected by lead dose level.

1549 **Effect of parasitism on the toxicity of cadmium to the three-spined stickleback, Gasterosteus aculeatus L.** Pascoe, D.; Cram, P. (Univ. of Wales Inst. of Science and Tech., Cardiff). **10**: No. 4, 467-472(25 Mar 1977).

The toxicity of cadmium to sticklebacks was determined over a wide range of concentrations. The 96 h LC50 was found to be 6.5 mg Cd l^{-1}. The shape of the time-concentration curve suggests that cadmium may have two toxic mechanisms. The median period of survival for fish infected with the plerocercoids of the cestode, Schistocephalus solidus, was found to be considerably shorter than for non-parasitized fish. This observation is considered in the light of the known effects of S. solidus on its host.

1550 **Effect of lead and cadmium on liver, kidney, and brain levels of cadmium, copper, lead, manganese, and zinc, and on erythrocyte ALA-D activity in mice.** Seth, T.D.; Agarwal, L.N.; Satija, N.K.; Hasan, M.Z. (Industrial Toxicology Research Centre, Lucknow, India). **16**: No. 2, 190-196(Aug 1976).

Lead and cadmium were administered intraperitoneally, singly and jointly, to mice. The levels of cadmium, copper, manganese, lead and zinc were determined in liver, kidney and brain by

atomic absorption spectrophotometric technique and delta-aminolevulinic acid dehydratase (ALA-D) activity was determined in erythrocytes. The tissue levels of some of these metals were found significantly altered by cadmium and lead, but cadmium was found to have no effect on blood ALA-D activity.

1551 Activity of Δ5-3β hydroxysteroid dehydrogenase enzyme in the interrenal tissue of rainbow trout (Salmo gairdneri Richardson) exposed to sublethal concentrations of zinc. Watson, T.A. (Univ. of Guelph, Ont.); McKeown, B.A. **16**: No. 2, 173-181(Aug 1976).

The effects of exposure of rainbow trout (Salmo gairdneri Richardson) to three sublethal concentrations of zinc (0.248, 0.528 and 1.14 ppM) on Δ5-3β-hydroxsteroid dehydrogenase (Δ5-3βHSDH) enzyme activity in the head kidney tissue was investigated. The activity of this enzyme was localized by the reduction of a tetrazolium salt to formazan at the site of activity. Using subjective methods to indicate the degree of activity and indirectly assess the degree of corticosteroid production, the zinc-exposed rainbow trout showed a greater degree of Δ5-3βHSDH activity compared to the control fish. This increase in enzyme activity has been associated with the stimulation of the pituitary-interrenal axis by the noxious stress of zinc.

1552 Effects of heavy metals on fin regeneration in the killifish, Fundulus heteroclitus. Weis, P.; Weis, J.S. (New Jersey Medical School, Newark). **16**: No. 2, 197-202(Aug 1976).

The experiments were designed to study the effects of mercury, lead and cadmium on fin regeneration in Fundulus. One mg/l mercury was lethal to the fish and all died before the first measurement. Fish in lead regenerated at slightly faster rates than the control fish. Cadmium strikingly retarded the rate of regeneration, although the effect was not correlated with the dose. This may be attributed to a limit in the amount of cadmium that the fish can accumulate. (MU)

1553 Pesticide and mercury levels in pelicans in Idaho. Benson, W.W.; Brock, D.W.; Gabica, J.; Loomis, M. (Dept. of Health and Welfare, Boise, ID). **15**: No. 5, 543-546(May 1976).

Levels of organochlorine pesticides and mercury residues found in the White Pelican, Pelicanus erythrorhynchos, in southern Idaho are reported. Twelve white pelicans were collected and autopsied to obtain specimens for mercury analysis. They were collected along the Snake River about three miles downstream from the American Falls Reservoir. An additional bird was tested for organochlorine pesticides. This bird was found dead in the Lake Lowell region of Idaho at about the same time the other birds were collected. Analysis was made on each organ tissue separately and the results reported on a wet weight basis. The highest levels of mercury were found in the liver tissues, the highest mercury level being 32.80 ppm and the lowest level in the particular tissue 2.33 ppm. The organochlorine residues were so high in the single bird studied for these pesticides as to possibly account for its death. (MU)

MAN

1554 Pulmonary distributions of lead in human subjects. Mylius, E.A.; Ophus, E.M. (Trondheim Univ., Norway). **17**: No. 3, 302-310(Mar 1977).

The concentration of lead in five lung segments and in regional lymph nodes was determined post mortem in ten subjects by atomic absorption technique. In each case there was a considerable variation in the concentration of lead in different lung segments, and, in general, the apical segment in the upper lobe tended to be more contaminated than segments in the lower lobes. With one exception, the lead levels in the regional lymph nodes exceeded those of the lung segments. Individual differences in the distribution of lead in the lungs may be due to differences both in exposure and physiological response. For comparative analyses, it is suggested that samples be taken from the same and preferably the basal segments of the lung.

OTHER ENVIRONMENTAL POLLUTANT EFFECTS

1555 (AD-A—039956) **Biological effects of nonionizing electromagnetic radiation. Volume 1. Number 3. A digest of current literature. Quarterly report Feb—Apr 1977.** Kleinstein, B.H. Apr 1977. 43p. NTIS PC A03/MF A01.

This digest presents current awareness information on the biological effects of nonionizing electromagnetic radiation (microwave and radiofrequency) in the range of 0 Hz to 100 GHz. The effects of magnetic and electric fields (static and alternating) are also covered. Each issue contains abstracts of English and foreign current literature, summaries of ongoing research investigations, news items, and a directory of meetings and conferences. (Author)

1556 (AD-A—041600) **Environmental pollution. noise pollution-noise effects on human performance. Report bibliography May 1974—Jan 1977.** Jun 1977. 324p. (DDC/BIB—77-07). NTIS PC A14/MF A01.

This bibliography is a selection of unclassified and unlimited distribution references on noise pollution-noise effects on human performance. These citations of reports present information on noise effects on human performance such as motor reactions, hearing speech, sleep, perception, nervous systems, visual signals and fatigue. Corporate author-monitoring agency, subject, title and personal author are provided.

1557 (NTIS/PS—77/0455) **Biological effects of microwaves (a bibliography with abstracts). Report for 1964—May 1977.** Harrison, E.A. Jun 1977. 192p. NTIS PC N01/MF N01.

The selected abstracts cover the biological effects on man and animals from exposure to microwaves. In addition to dosages and tolerances, regulations and standards are included. (This updated bibliography contains 187 abstracts, 35 of which are new entries to the previous edition.)

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 1355, 1373

1558 (SAND—77-0857) **Safety inspection guide, Mod III (a systematic approach to conducting a safety inspection).** Davidson, J.E. Jun 1977. Contract EY-76-C-04-0789. 54p. Dep. NTIS, PC A04/MF A01.

This guide was developed as a comprehensive/systematic approach to the problem of performing a safety inspection. Five basic sections (categories) are considered in the guide: physical work place; machines/mechanical equipment; hazardous materials/processes/environments; energy sources; and management hazard . control factors. The basic concept is that one starts evaluating hazard potentials from the physical work place and continues considering other elements as they are added to the physical work place. This approach provides a better understanding of the interfaces of each section to the entire group. The guide is supported by an Area Safety Inspection Result form to record defects or conditions found, the evaluation (best estimate) of the urgency or priority for correcting deficiencies or areas of noncompliance, and the status of corrective action. Additionally, the guide serves as an educational tool in accident prevention for supervisors and employees.

1559 Method and apparatus for monitoring optical radiation. Landry, R.J.; Bostrom, R.G.; Peterson, R.W. US Patent 4,015,130. 29 Mar 1977. Filed date 7 Oct 1975. 7p.

A method and apparatus is described for monitoring optical radiation which, in a preferred embodiment, takes the form of a biologically weighted ultraviolet radiant energy monitor which provides a direct indication of the hazards to humans from the ultraviolet radiation source being monitored. The source of radiation is first spectrally dispersed by passage through a suitable prism or diffraction grating. Portions of the spectrally dispersed radiation are mechanically masked in accordance with a predetermined biological weighting. The subsequent weighted output from the mechanical mask is then fed to a suitable detector. A quartz prism or diffraction grating spectrograph is utilized to spectrally disperse the incident radiation spatially and a plate coated with sodium salicylate or other suitable converter is placed in the exit plane of the spectrograph. The sodium salicylate plate fluoresces in the blue in response to incident ultraviolet radiation. The intensity of the biologically weighted blue light may then be conveniently and readily detected by a blue sensitive detector to provide an immediate readout of the potential ultraviolet radiation hazard from the unknown optical source.

GEOSCIENCES

GEOLOGY AND HYDROLOGY

REFER ALSO TO CITATION(S) 1386, 1387, 1388, 1389, 1390, 1410

1560 (USGS—474-243) **Composite postshot fracture map of Pahute Mesa, Nevada Test Site, June 1973—March 1976. Special studies-95.** Maldonado, F. 1977. Contract EY-76-C-04-0474. 22p. Dep. NTIS, PC A02/MF A01.

During 1973-76, 13 underground nuclear tests were conducted on Pahute Mesa Nevada Test Site, for which explosion-induced

surface effects were mapped. Surface effects consist predominantly of movements along previously mapped faults.

MINERALOGY, PETROLOGY, AND ROCK MECHANICS

REFER ALSO TO CITATION(S) 202, 326

1561 (UCID—17527) **Rock Mechanics Project progress and results: rock fracture and pore collapse.** Schatz, J.; Kusubov, A.; Hearst, J.; Abey, A.; Snell, C.; Thigpen, L. May 1977. Contract W-7405-ENG-48. 50p. Dep. NTIS, PC A03/MF A01.

Problems in rock fracture and pore collapse were studied with the intent of understanding mechanisms of and developing models for rubble formation, permeability enhancement, and wave propagation. Results are reported for studies on explosive-induced fracture and fluid flow in a gas-bearing sandstone at confining pressures to simulate in situ conditions; explosive-induced fracture in a brittle plastic with multiple charges fired both simultaneously and sequentially; the effect of several intermediate-strain rates on strength and fracture in limestone; and development and testing of a theoretical model for yielding and pore collapse in porous rocks. The specific technical objectives of the project is to understand the physical mechanisms and develop models for the creation of fractured material or rubble and the enhancement of permeability by underground high-explosive detonations. This understanding will benefit in situ energy and resource technologies that use high explosives to achieve or enhance recovery of underground resources.

1562 (UCRL—79058) **Elasticity of stishovite revisited.** Chung, D.H. 15 Jul 1977. Contract W-7405-ENG-48. 25p. (CONF-770706—20). Dep. NTIS, PC A02/MF A01.

From 6. AIRAPT international high-pressure conference; Boulder, Colorado, United States of America (USA) (25 Jul 1977).

The belief that stishovite is a mineral present in the earth's mantle as a separate phase makes this material rather important in geophysics. New elastic moduli for stishovite, which result from the self-consistent approximation based on an experimental study of AgCl-stishovite mixtures, are presented. This information is used to construct the solid equations of state of stishovite on the basis of phenomenological laws of the velocity-density-mean atomic weight relation and recent static and dynamic shock compression data. A new interpretation of the composition of the earth's lower mantle is made.

1563 Electromagnetic emission accompanying fracture of quartz-bearing rocks. Nitsan, U. (Geological Research Group, Los Alamos Scientific Laboratory, Los Alamos, NM 87545). **4**: No. 8, 333-336(Aug 1977).

Fracture of quartz-bearing rocks and other hard piezoelectric materials is associated with radio frequency (RF) electromagnetic emission that can be readily detected in the laboratory. Using a standard RF coil and a transient recorder it was found that small cracks in quartz and tourmaline single crystals produce exponentially-decaying RF transients with a time constant of about 10^{-5} s. Failure of quartz-bearing rocks generates longer and more complex transients, presumably due to interference of radiation emitted by numerous piezoelectric crystals as a result of the sudden drop in piezoelectric field accompanying the release of stress. The spectral content of these transients depends on grain size, shifting to higher frequencies as grain size decreases. This fracture-related emission has a variety of potential geophysical applications ranging from monitoring cracks in rock deformation experiments to studies of electromagnetic effects associated with earthquakes, hydraulic fracture and mine failure.

1564 (AD-A—041251) **Determination of the permeability of the frozen fissured rock massif in the vicinity of the Kolyma hydroelectric power station.** Pogrebiskii, M.I.; Chernyshev, S.N. Translated from **39**: No. 1, 28-31(Jan 1975). 17p. (CRREL-TL—634). NTIS PC A02/MF A01.

This report provides the rough estimates of the actual coefficients of filtration, since some of the parameters of fissuring were assigned arbitrarily in the computations. The only method of predicting the permeability of the thawed state of the massif is calculating the filtration coefficient from the geometry of the fissures. This makes it possible incidently, to calculate the filtration coefficient of the massif in the frozen state. The granite foundation of the Kolyma Hydroelectric Power Station is broken up by fissures of considerable width suggesting that the rock is highly permeable.

PHYSICS RESEARCH

1565 (LA—6816-PR) **Theoretical Division annual report, July 1975—September 1976.** Cooper, N.G. (comp.). Jul 1977. Contract W-7405-ENG-36. 158p. Dep. NTIS, PC A08/MF A01.

This report covers the unclassified work of T Division during FY76 and 76T. Part I, the Introduction, introduces the organization, functions, and goals of the Division and highlights recent changes therein. Part II describes programmatic research on energy and weapons problems. Part III is organized by discipline and contains status reports from all group leaders as well as selected articles by individual staff members on research projects of special interest.

ASTROPHYSICS AND COSMOLOGY

1566 (LA—6760-M) **Astrophysical opacity library.** Huebner, W.F.; Merts, A.L.; Magee, N.H. Jr.; Argo, M.F. Aug 1977. Contract W-7405-ENG-36. 15p. Dep. NTIS, PC A02/MF A01.

The astrophysical elements opacity library includes equation of state data, various mean opacities, and 2000 values of the frequency-dependent extinction coefficients in equally spaced intervals u identical with $h\nu/kT$ from 0 to 20 for 41 degeneracy parameters eta from -28 (nondegenerate) to 500 and 46 temperatures kT from 1 eV to 100 keV. Among available auxiliary quantities are the free electron density, mass density, and plasma cutoff frequency. A library-associated program can produce opacities for mixtures with up to 20 astrophysically abundant constituent elements at 4 levels of utility for the user.

COSMIC RADIATION

1567 Zenith-angle distributions of atmospheric muons above 20 GeV. Decoster, R.J.; Stevenson, M.L. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.); Toner, W.T.; Zipf, T.F. (Stanford Linear Accelerator Center, Calif. (USA)); Breakstone, A.; Flatte, S.M. (California Univ., Santa Cruz (USA)). **12**: No. 8, 239-245(22 Feb 1975).

The results of a magnetic-spectrometer experiment at ground level with optical spark chambers, scintillator hodoscope trigger and an air-gap magnet, are reported to given an evaluation of the zenith-angle distribution of the atmospheric muons above 20 GeV. An automatic flying spot digitizer, the Hummingbird, was used.

1568 (UCRL-Trans—11258) **Elements of the physical theory of meteors and crater-forming meteorites.** Stanyukovich, K.P. Translated from No. 7, 39-62(1950). 43p. Dep. NTIS, PC A03/MF A01.

An analysis is made on the basis of the data of contemporary aerodynamics, of the fundamental regularities of the motion of meteoroids, meteorites, with the earth's surface with cosmic velocity. Also the phenomena that occur upon such a collision are considered. The motion of meteoroids in the atmosphere and meteorite impacts against planetary surfaces are discussed. 14 references (JFP)

STARS

1569 Physical conditions in the atmospheres of M giants. Komarov, N.S.; Gladushina, N.A.; Mishenina, T.V. (Odessa University Observatory). **21**: No. 1, 26-29(Jan 1977).

Fifteen spectrograms of the M giants δ^2 Lyr and g Her obtained at 14-A/mm dispersion are analyzed. The physical parameters of the atmospheres at each epoch of observation are determined by means of curves of growth. The vibration temperature is estimated from the α-system bands of TiO.

1570 Acceleration of relativistic electrons in a supernova explosion. Bychkov, K.V. (Special Astrophysical Observatory, USSR Academy of Sciences). **21**: No. 1, 48-54(Jan 1977).

Various models for the acceleration of relativistic electrons in supernova envelopes, both during the early stage and at the onset of deceleration of the envelope by the interstellar gas swept up, are examined critically. Conditions are established such that relativistic electrons can be generated by the following sequence: γ-decay of ^{56}Ni→positron annihilation with the formation of γ-ray photons→scattering of the γ rays with the formation of subrelativistic electrons→preliminary acceleration of the particles with their conservation in a closed "synchrotron boiler"→final acceleration by MHD waves. These conditions are: an adequate number of ^{56}Ni nuclei (up to 10^{56}); significant inhomogeneity in the envelope, which would contain both cool ($T < \text{or} = 10^{40}$K) and hot ($T > \text{or} = 3\times10^{40}$K) gas phase, with particle acceleration in the hot regions; and collision of two inhomogeneous envelopes, whereby dense knots would entangle the magnetic field lines of the envelopes and so generate MHD waves. Ultrarelativistic ions cannot be accelerated by this process because of the stringent constraints on the injection.

A mechanism is proposed for supplementary acceleration of cosmic rays in Cas A in the vicinity of the nonsteady filaments; it entails stretching of the magnetic field lines by the filaments until they are drawn out of the nebula. The envelope parameters are determined at various stages. Observational tests of several models are suggested.

1571 Some implications of Smith's pulsar model. Malov, I.F.; Malofeev, V.M. (Lebedev Physics Institute, USSR Academy of Sciences, Moscow). **21**: No. 1, 55-57(Jan 1977).

The electron energy $\epsilon=\gamma m/\text{sub } e/c^2$ in the pulsar reference frame is evaluated on the basis of F. G. Smith's mechanism. The dipole magnetic field model is inconsistent with the observations because it would imply $\gamma<1$ for some pulsars. The factor γ does not remain constant in the emission zone, and the radiation emitted there is not monochromatic.

1572 Low-temperature peculiarities in the melting curves of Fermi crystals, and their implications for neutron stars. Bruk, Y.M.; Kugel', K.I. (Institute of High Pressure Physics, USSR Academy of Sciences). **21**: No. 1, 57-60(Jan 1977).

A discussion is given of the possible existence of low-temperature anomalies in the p/sub c/(T) melting curves for Fermi quantum crystals. Some consequences of these anomalies are outlined. In addition to the Pomeranchuk minimum in p/sub c/(T) at T≅T/sub F/ (T/sub F/ is the Fermi temperature), p/sub c/(T) can behave nonmonotonically at ultralow temperatures Tvery-much-less-thanT/sub F/. The cases of normal and superfluid Fermi systems are considered. Application of the thermodynamic scheme discussed here to nucleon material in the central part of neutron stars indicates that the thermal evolution of crystalline neutron cores will be nonmonotonic. In all cases, however, the thermal evolution of the neutron crystal will lead to the release of energy. The characteristic time intervals between starquakes and the accompanying glitches in a pulsar rotation period will depend in this model on the cooling rate of the neutron star. Starquakes would themselves be possible even for old neutron stars that have cooled below 10^8 °K.

1573 Sequences of model stars of decreasing mass in thermal equilibrium. Kraicheva, Z.T.; Tutukov, A.V.; Yungel'son, L.R. (Astronomy Section, Bulgarian Academy of Sciences, Sofia). **21**: No. 1, 61-65(Jan 1977).

Nonevolutionary sequences of models in thermal equilibrium are calculated for stars of decreasing mass with helium burning in their core. The mass of the initial models is 16—64 M/sub sun/The Schwarzschild convective-stability criterion is assumed satisfied in the zone of variable molecular weight. If the mass ratio of contact-binary components filling the Roche lobe is M/sub 1,0//M/sub 2,0/ ≅1, and if their initial mass M/sub 1,0/9 or ≈19 M/sub sun/then they should lose mass on a thermal time scale, but if M/sub 1,0/> or ≈19 M/sub sun/mass loss should occur on the time scale of the He burning in the core. For M/sub 1,0//M/sub 2,0/≅3, the corresponding changeover value is M/sub 1,0/≅24 M/sub sun/intervals between starquakes and the accompanying glitches in a pulsar rotation period will depend in this model on the cooling rate of the neutron star. Starquakes would themselves be possible even for old neutron stars that have cooled below 10^8 °K.

QUASI-STELLAR, RADIO, AND X-RAY SOURCES

1574 Observation of X-rays from the Crab Pulsar. Toor, A.; Seward, F.D. (Lawrence Livermore Laboratory, University of California). **216**: No. 2, 560-564(1 Sep 1977).

A measurement of the pulsed X-ray emission from the Crab Nebula made during a lunar occultation is presented. Comparison is made with previous observations, and possible variations in this pulsed emission are discussed.

1575 Plasma turbulent reactors. Norman, C.A. (Department of Astronomy, 12 Parks Road, Oxford, United Kingdom). **106**: No. 1, 26-43(Jul 1977).

Similarity solutions are found for the evolution of the distribution functions of the radiation and relativistic electrons in a plasma turbulent reactor (PTR). These solutions have a "universal" power-law form which is shown to be analogous to the Kolmogorov spectrum for fluid turbulence and stable in the same sense. These results appear to have a minimal model dependence and may have considerable implications for our understanding of nonthermal radiation sources in astrophysics which have power-law spectra. The PTR theory gives two values for the resultant radiation spectrum if the PTR's relativistic electrons are placed in an optically thin environment, namely a spectral falloff of $\omega/\text{sup } -0.5/$ and ω^{-1} in remarkably close agreement with the observed values.

SOLAR PHENOMENA

1576 (AD-A—039944) Force free magnetic fields and solar activity. Final report 1 Jul 1974—31 Dec 1976. Sturrock, P.A.; Barnes, C.W. Dec 1976. Contract F19628-74-C-0054. 27p. NTIS PC A03/MF A01.

This study, aimed at the prediction of solar flares, centers on devising methods for calculating magnetic field structures in the solar atmosphere. Force-free fields comprise an important class of magnetic-field structures which may be calculated by relaxation techniques. Models under active consideration involve spherical boundary surfaces and cylindrical symmetry. Study of the energy of such field configurations indicates that, for sufficiently large shear, force-free fields will be unstable against perturbations leading to eruption. The condition for this instability and the mechanism of instability have been investigated. The studies are related to erupting prominences and coronal transients, as well as solar flares. (Author)

1577 (AD-A—040039) Observational research on solar coronal waves. Final report 1 Sep 1974—30 Sep 1976. Zirker, J.B. 31 Dec 1976. Contract F19628-75-C-0067. 18p. NTIS PC A02/MF A01.

An observational search has been made for intensity fluctuations associated with the wave motions that are thought to heat the corona. Brightness changes in the coronal green line (Fe XIV lambda 5303) and the coronal continuum were measured with the University of Hawaii's polarimeter at Mt. Haleakala. Upper limits of fluctuations associated with wave heating were 0.2% and 6% in the line and continuum, respectively. Spectra of quiescent prominences have been analyzed to determine whether any correlation exists between temperature and microturbulence, which could be consistent with wave heating of prominences. Kinetic temperatures range from 8000 to 11000 K, rms turbulent velocities range from 3 to 8 km/s. No correlation between temperature and microturbulence was found. Some evidence for a gradient in kinetic temperature and for gross oscillations of an entire prominence, was found. (Author)

1578 (LA-UR—77-1055) Helium (3) rich solar flares. Colgate, S.A.; Audouze, J.; Fowler, W.A. 1977. Contract W-7405-ENG-36. 7p. (CONF-770808—2). Dep. NTIS, PC A02/MF A01.

From 15. international Cosmic Ray Conference; Provdiv, Bulgaria (13 Aug 1977).

The extreme enrichment of $^3He/^4He \geqq 1$ in some solar flares as due to spallation and the subsequent confinement of the products in a high temperature, kT ≃ 200 keV, high density, n/sub e/ ≃ 3 x 10^{15} cm^{-3} plasma associated with the magnetic instability producing the flare is interpreted. The pinch or filament is a current of high energy protons that creates the spallation and maintains the temperature that produces the high energy x-ray spectrum and depletes other isotopes D, Li, Be, and B as observed. Finally the high temperature plasma is a uniquely efficient spallation target that is powered by the interaction of stellar convection and self generated magnetic field.

1579 (PB—266959) A three-dimensional model of high-speed streams in the solar wind. Doctoral thesis. Pizzo, V.J. 1977. Contract NSF-C760. 295p. (NCAR-CT—43). NTIS PC A13/MF A01.

A single-fluid, nonlinear, adiabatic, 3-D, hydrodynamic numerical model is developed to study the global dynamics of steady, corotating solar wind streams in the supersonic flow regime beyond 35 solar radii.

1580 Unusual aspect of solar wind speed variations during solar cycle 20. Gosling, J.T.; Asbridge, J.R.; Bame, S.J. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). **82**: No. 22, 3311-3314(1 Aug 1977).

Geomagnetic records from 1868 through 1975 indicate that geomagnetic activity during 1973—1975 was unusually enhanced for that phase of the sunspot cycle (5—7 years after solar maximum). Previous work indicates that long-term variations in geomagnetic activity are closely coupled to long-term variations in the bulk flow speed of the solar wind. Thus we infer that reported averages of the solar wind speed for the 1973—1975 era are unusually large for that phase of the sunspot cycle.

1581 Determination of some parameters and the fine structure of chromospheric flares. Babaev, A.G.; Guseinov, R.E.; Rustamov, A.A. (Shemakha Astrophysical Observatory, Academy of Sciences of the Azerbaidzhan SSR). **21**: No. 1, 69-73(Jan 1977).

A method is presented for the joint determination of the optical thickness at the center of the Hα line, the electron temperature, and the emission measure, of chromospheric flares. The lower limit of the kinetic temperature in flares is found (7500°K). Evidently, after the maximum phase the broadening of the filaments occurs, then their combination into larger filaments (with a decreasing concentration), and the gradual disappearance of the filamentary nature of the structure.

1582 Fine structure of the type II solar radio burst of May 3, 1973. Urbarz, H.W.; Fomichev, V.V.; Chertok, I.M. (Astronomical Institute of Tuebingen University). **21**: No. 1, 77-81(Jan 1977).

Fluctuations of the radio radiation in the type II bursts of May 3, 1973 are analyzed on the basis of data obtained with the Weissenau (FRG) spectrograph in the range of 30—960 MHz and with the polarimeter of the Institute of Terrestrial Magnetism, the Ionosphere, and Radio-Wave Propagation, USSR Academy of Sci-

ences at a frequency of 74 MHz. The characteristic time scale of these fluctuations at 74 MHz decreases during an event from 2—5 to 1—3 sec. It is shown that the origin of the fluctuations is connected with the presence in the corona of heterogeneities of the magnetic field and the electron density. The heterogeneities consist of formations strongly drawn out along the surface of the sun. Their radial dimensions are l/sub parallel/(2—7) x10^8 cm and they grow with an increase in distance from the sun. The transverse dimensions of the heterogeneities are l/sub perpendicular10/ cm.

1583 Some results of observations of solar radio bursts of the "drifting pairs" type near frequencies of 25 and 12.5 MHz. Abranin, E.P.; Bazelyan, L.L.; Goncharov, N.Y.; Zaitsev, V.V.; Zinichev, V.A.; Levin, B.N.; Rapoport, V.O.; Tsybko, Y.G. (Institute of Radiophysics and Electronics, Academy of Sciences of the Ukrainian SSR, Khar'kov.). **21**: No. 1, 82-88(Jan 1977).

The double structure of solar radio bursts of the drifting pairs type is usually associated with the effect of a radio echo in the regular spherically symmetrical solar corona. In this case it is assumed that these double bursts originate at a frequency close to the second harmonic of the local plasma frequency in the region of generation. In the present report on the basis of observations of drifting pairs in the frequency ranges of 12—13 and 24—26 MHz it is shown that double bursts can be observed both at the second and at the first harmonic. The time interval between the elements of the double burst remains almost constant in this case. This circumstance creates serious difficulties in an interpretation of double bursts through the effect of a radio echo in the solar corona. The hypothesis is advanced that the double (and multiple in general) structure of the bursts may be connected with the successive passage of a beam of fast electrons through regions of double plasma resonance. Here it is assumed that the radiation originates through a cyclotron instability at the leading front of the electron beam moving along the decreasing magnetic field of a coronal ray. It is shown that the properties of these bursts can be explained using the proposed mechanism of formation of drifting pairs.

1584 Propagation of a magnetohydrodynamic shock wave in the solar atmosphere. Zakaidakov, V.V.; Synakh, V.S. (Computation Center, Siberian Branch of the USSR Academy of Sciences). **21**: No. 1, 89-91(Jan 1977).

The propagation of a magnetohydrodynamic shock wave in the nonuniform chromosphere and corona is studied using numerical modeling. The finite conductivity of the plasma and the magnetic field are taken into account. It is shown that the shock wave leads to dissipation of the magnetic field behind the front and to heating of the plasma as a whole. The profiles of the principal quantities obtained are used to estimate the intensity of radiation from the region directly behind the shock wave front at the fundamental and double plasma frequencies.

GALAXIES

1585 Correlation function for density perturbations in an expanding universe. I. Linear theory. McClelland, J.; Silk, J. (Department of Physics and Space Sciences Laboratory, University of California, Berkeley). **216**: No. 3, 665-681(15 Sep 1977).

We derive analytic solutions for the evolution of linearized adiabatic spherically symmetric density perturbations and the two-point correlation function in two regimes of the early universe: the radiation-dominated regime prior to decoupling, and the matter-dominated regime after decoupling. The solutions are for an Einstein—de Sitter universe, and include pressure effects. In the radiation era, we find that individual spherically symmetric adiabatic density perturbations smaller than the Jeans length flow outward like water waves instead of oscillating as infinite plane waves. It seems likely that the only primordial structures on scales smaller than the maximum Jeans length which could survive are very regular waves such as infinite plane waves. However, structure does build up in the correlation function over distances comparable with the maximum Jeans length in the radiation regime, and could lead to the eventual formation of galaxy superclusters. This scale ($\sim 10^{17}\ \Omega^{-2}$ M/sub sun)/therefore provides a natural dimension for large-scale structure arising out of the early universe. A general technique is described for constructing solutions for the evolution of the two-point correlation function, and applied to study white noise and power-law initial conditions for primordial inhomogeneities.

1586 Vibrationally excited molecular hydrogen in Orion. Hollenbach, D.J.; Shull, J.M. (Department of Astronomy, University of California, Berkeley). **216**: No. 2, 419-426(1 Sep 1977).

Physical mechanisms for producing vibrationally excited molecular hydrogen, such as has recently been detected toward the Orion Nebula, are discussed. The most likely mechanisms are: (i) collisional excitation behind a shock moving into a molecular cloud; and (ii) near-ultraviolet pumping in the H_2 Lyman and Werner bands and subsequent cascade. The absolute intensities of the Orion lines require either: (i) a 10 km s^{-1} shock moving into a 3 x 10^5 cm^{-3} cloud; or (ii) an incident near-UV flux 10^6 times the mean interstellar value. The shock model is favored because it matches the observed relative line intensities and because the near-UV source, θ^1 Ori C, may be too weak to provide the required flux. We predict intensities of other H_2 lines in our shock model as a further observational discriminant.

1587 Grain disruption in interstellar hydromagnetic shocks. Shull, J.M. (Department of Astronomy, University of California, Berkeley). **215**: No. 3, 805-811(1 Aug 1977).

The observed abundance variations of Ca, Fe, Si, and Ti in intermediate-velocity interstellar gas suggest that grains have been disrupted in clouds with velocities as low as 20—50 km s^{-1}. In this paper, we describe a simplified hydromagnetic shock model for such clouds, derive the dynamical equations for charged grains in the postshock region, including the collisional drag and "betatron-acceleration" effect of a magnetic field gradient, and thereby calculate the fraction of grains destroyed in evaporative collisions with other grains. We find that for shocks of 20—50 km s^{-1} in which the fractional H-ionization remains low, 3—10% of the grain material may be destroyed: sufficient to explain in part the heavy-element depletion pattern in intermediate velocity clouds and the well-known correlation of N (Ca II)/N (Na I) with cloud velocity.

1588 Destruction of interstellar dust grains by cosmic rays. Kessel'man, V.S. **21**: No. 1, 14-16(Jan 1977).

A hydrodynamic mechanism is proposed for the destruction of interstellar dust grains by cosmic rays.

1589 Interstellar CH molecule: structure of the rotational levels and mechanisms of excitation. Burdyuzha, V.V.; Zhilinskii, V.I.; Reitblat, A.A. (Institute for Space Research, USSR Academy of Sciences, Moscow). **21**: No. 1, 17-25(Jan 1977).

The structural properties of the low rotational levels of the CH molecule are considered. Approximate values are obtained for the hyperfine-interaction and Λ-doubling constants. Various mechanisms are discussed for exciting the $F=0^{+-}1^{+-}$ rotational sublevels of the ^{2}Pi/sub 1/2/ (J=1/2) state of the CH molecule: photodissociation of the CH_2 molecule, collision with H, and interaction with a directive flux of far-infrared radiation. An observational test to verify these excitation mechanisms is suggested.

COSMOLOGY

1590 Luminosity distance equation in Friedmann cosmology. Terrell, J. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87544). **45**: No. 9, 869-870(Sep 1977).

We propose a new form of the luminosity distance equation (and of the apparent distance equation), for Friedmann cosmological models which appears to have advantages once the usual equation in clarity, convenience, and computational accuracy.

ATMOSPHERIC PHYSICS

1591 Ozone transport from stratosphere to troposphere. Husain, L.; Coffey, P.E.; Meyers, R.E.; Cederwall, R.T. (Division of Laboratories and Research, New York State Department of Health, Albany, N.Y. 12201). **4**: No. 9, 363-365(Sep 1977).

^{7}Be produced by the interaction of cosmic rays with oxygen and nitrogen, predominantly in the stratosphere, has been used to identify and measure stratospheric ozone at the ground level. Simultaneous measurements at Whiteface Mountain, New York, in July 1975 show that the maximum ^{7}Be concentrations are accompanied by increased ozone concentrations. Peaks in ^{7}Be concentrations occurred on July 5-6, 11-12, 16-17, 23, and 27. Ozone peaks were observed on July 7-9, 11, 18, 24, and 27. Isentropic trajectory calculations also showed that the trajectories reaching Whiteface Mountain on July 11-12, 15-16, 23, and 27 had stratospheric origin. One-day delay in ozone peaks on July 7-9, 18, and 24 is attributed to increased tropospheric ozone production. The observed relationship between ^{7}Be and ozone is used to deduce an upper limit of 37 ppb stratospheric ozone at Whiteface Mountain during July 1975. Thus, even during midsummer months, when stratospheric-tropospheric mass exchange is not at a maximum, stratospheric ozone may contribute substantially to the national ambient air quality standard of 80 ppb.

AURORAL AND IONOSPHERIC PHENOMENA

1592 (AD-A—039894) **The relationship between polar cap riometer absorption and solar particles. Final report 12 Nov 1975—12 Jan 1977.** Sellers, B.; Hanser, F.A. Apr 1977. Contract F19628-76-C-0106. 37p. NTIS PC A03/MF A01.

A detailed investigation of the approximate square-root relationship between riometer absorption and solar proton fluxes has been carried out. The relationship is shown to be valid for night as well as day conditions, with differences in the constants. The atmo-

spheric chemistry basis for the differences in the constants is discussed.

1593 (AD-A—041599) **Calculations of soft auroral bremsstrahlung and K alpha line emission at satellite altitude. Interim report.** Luhmann, J.G.; Blake, J.B. 23 Jun 1977. Contract F04701-76-C-0077. 31p. NTIS PC A03/MF A01.

Satellite altitude (450 km) fluxes of 0.1- to 10-keV auroral x-rays are calculated for some typical forms of incident electron spectra. Both bremsstrahlung and K alpha line emission are included. These calculations indicate that K alpha emission can increase the observable intensity of satellite altitude auroral x-rays by up to 100 times. Soft x-rays are thus an ideal medium for imaging the aurora.

1594 (PB—269620) **Data description and quality assessment of ionospheric electron density profiles for ARPA modeling project. Technical report.** Conkright, R.O. Mar 1977. 89p. (NOAA-TR-EDS—16; NGSDC—1). NTIS PC A05/MF A01.

This report presents a description of the automated method used to produce electron density (N(h)) profiles from ionograms recorded on 35mm film and an assessment of the resulting data base. A large data base of about 30,000 profiles was required for an ionospheric modeling project. This motivated a search for an automated method of producing profiles. The automated method used is fully described, the resulting data are given a quality grade, and the noon and midnight profiles are presented. Selected portions of this data base are compared with profiles produced by the standard profiling method in use by the Environmental Data Service at Boulder, Colorado.

1595 **Saturation of the modulational instability of narrow radio beams in a magnetized plasma.** Vas'kov, V.V.; Gurevich, A.V. (Institute of Terrestrial Magnetism, the Inosphere, and Radio Propagation, Academy of Sciences of the USSR). **3**: No. 2, 185-190(Mar 1977).

A method is proposed for studying the saturation of the modulational instability of electromagnetic waves. The nonlinear stage of the instability of narrow radio beams in a magnetized plasma is analyzed. The scale length of the plasma stratification and the magnitude of the perturbations in the plasma density which form are found as functions of the intensity of the pump wave. The general equations are illustrated for the case of conditions corresponding to the upper ionosphere.

1596 **Shortwave drift-dissipative instability.** Borisov, N.D.; Vas'kov, V.V.; Gurevich, A.V. (Institute of Terrestrial Magnetism, the Ionosphere, and Radio Propagation, Academy of Sciences of the USSR). **3**: No. 1, 97-98(Jan 1977).

The kinetic equation is solved and dispersion relations derived for the drift-dissipative instability of a low-pressure plasma.(AIP)

EFFECTS OF NUCLEAR DETONATIONS

1597 (AD-A—041092) **AIRDIF: a two-dimensional atmospheric radiation diffusion computer code. Final report.** Shulstad, R.A.; Wolf, E.L. Jun 1977. 102p. (AFWL-TR—77-29). NTIS PC A06/MF A01.

This report contains a user's guide for the AIRDIF code. AIRDIF is a computer code which employs a special form of diffusion theory to compute free field radiation environments from atmospheric nuclear detonations. The code may be run in either homogeneous air or 2-D variable density air. In addition to environments, AIRDIF is also capable of computing K-Factors, defined to be the ratio of the 2-D 4 pi sq r variable density air dose to the 1-D mass integral scaled dose, for a particular source, dose response function, and at a number of mass ranges.

MAGNETOSPHERIC PHENOMENA

1598 (AD-A—039763) **Low-energy particle experiment. Annual technical report 1 Apr 1976—31 Mar 1977.** Shelley, E.G. 30 Mar 1977. Contract N00014-72-C-0234. 58p. (LMSC/D—558252). Microfiche copies only.

This program is directed toward an improved understanding of the sources and the energization, transport and loss processes associated with the low-energy (keV) plasmas in the earth's magnetosphere. A low-energy particle experiment was launched on the Air Force S3-3 satellite in July of 1976. The experiment is operating completely successfully and has already made several major discoveries about previously unknown ionospheric acceleration mechanisms and the composition of the ring current. (Author)

ATOMIC, MOLECULAR, AND CHEMICAL PHYSICS

1599 **Potential energy curves and predicted fluorescence for neon fluoride.** Winter, N.W.; Bender, C.F.; Rescigno, T.N. (University of California, Lawrence Livermore Laboratory, P. O. Box 808, Livermore, California 94550). **67**: No. 7, 3122-3125(1 Oct 1977).

Potential energy curves for the lowest four states of NeF have been computed and used to determine the bound-free Franck—Condon factors. Combining these with the calculated transition moments, the fluorescence spectra of NeF has been predicted. The dominant feature is the charge transfer band $2\ ^2\Sigma \rightarrow 1\ ^2\Sigma$ at 108 nm. Several other weaker transitions are shown to overlap this band.

1600 **Oscillator strengths for the magnesium isoelectronic sequence.** Shorer, P.; Lin, C.D.; Johnson, W.R. (Center for Astrophysics, Harvard College Observatory and Smithsonian Astrophysical Observatory, Cambridge, Massachusetts 02138). **16**: No. 3, 1109-1116(Sep 1977).

The relativistic random-phase approximation is used to calculate the excitation energies and absorption oscillator strengths for the $3s^2\ ^1S_0$-$3s3p\ ^1P_1$, -$3s4p\ ^1P_1$, -$3s5p\ ^1P_1$, and -$3s3p\ ^3P_1$ transitions of selected elements of the magnesium isoelectronic sequence through nuclear charge Z = 92. The results are compared with previous theoretical and experimental values. The data, plotted as a function of Z^{-1} enable us to study deviations from the predictions of the nonrelativistic Z-expansion theory.

BEAMS AND THEIR REACTIONS

1601 **Projected range calculations of radionuclide product ejection from metal surfaces by 14.8-MeV neutrons.** Lessor, D.L.; Thomas, M.T.; Harling, O.K. (Batelle Pacific Northwest Laboratories, Richland, Washington 99352). **48**: No. 10, 4337-4343(Oct 1977).

A calculation has been made of the radionuclide product ejection from several elemental metal foils and a stain-steel alloy foil from (n,x) reactions in a normally incident 14.8-MeV neutron flux and compared with experimental data. The recoiling heavy products from the (n,x) reactions were assumed to propagate on the average in straight lines with a definite range-vs-energy relationship. With this assumption, for each distance x from the surface, an angle θ/sup cm//sub c/ is found such that product nuclei at center-of-mass angles θ/sup cm/$<\theta$/sup cm//sub c/ leave the material while those at angle θ/sup cm/$>\theta$/sup cm//sub c/ on the average come to rest in the material medium. Calculated sputtering rates range from slightly below to a factor of 2 above experimental values. This agreement is judged to be good considering the assumptions of the model, the assumptions used to generate the range tables, and the uncertainties in the experimentally determined sputtering rates.

1602 **Effect of anomalous conductivity on the structure of the anode sheath in a Hall-current ion source.** Popov, Y.S.; Zolotaikin, Y.M. **3**: No. 2, 210-212(Mar 1977).

The effect of the anomalous transverse electron mobility on the structure of the anode sheath and the characteristics of a Hall-current ion source is studied. The distributions of the densities of charged and neutral particles, the potential, and the electron temperature through the sheath are found. The probability for the ionization of the neutral atoms is calculated as a function of the level of the fluctuations in the electron density for various values of the magnetic field, the discharge voltage, and the flow rate of the working medium. An increase in the fluctuation level leads to an increase in the thickness of the anode sheath and to an increase in the ionization probability.

1603 **Ion dynamics in neutralized ion beams with ionization and burnup of neutrals.** Melikov, I.V.; Morozov, A.I. **3**: No. 2, 221-225(Mar 1977).

A comparison is made of theoretical and experimental results on the dynamics of ions in a neutralized ion beam in a Hall-current plasma accelerator. When ionization and "burnup" of neutral atoms are taken into account, it becomes possible to use the kinetic approximation to calculate the equilibrium configurations of a neutralized ion beam with a continuous supply of the neutral component when the distribution of the electric field and the electron temperature along the beam are known. The behavior of the electron temperature in the anode region is studied for the case of the minimum discharge voltage, which is the most typical case for a self-sustained discharge. In this state of the plasma, the ionization coefficient is constant for the same mass flux densities of various substances, and the ionization rate is constant at different flow rates. These results can be explained on the basis of an analysis of the scaling of the processes operating in the accelerator. The coefficient for ionization of the working medium by electron impact is calculated on the basis of various models for ionization for T/sub e/ up to 20 eV. The results are in close agreement.

1604 **Contribution to the investigation of ion impact desorption by ion scattering.** Taglauer, E.; Marin, G.; Heiland, W. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). **13**: 47-49(1977).

Sputtering or ion impact desorption of adsorbed layers can be directly investigated by low-energy ion scattering. Because of its specific sensitivity to surface atoms, this method provides the possibility of monitoring the decrease of the signal from the adsorbate or

the increase of the signal from the substrate. Both signals were studied with He^+ backscattering from the system O on Ni (110). The measured desorption cross-sections and the principal implications for both ways of observation are discussed. The use of the substrate signal for the desorption study can be of major advantage, particularly in the case of light adsorbates.

1605 Investigations of radiative electron capture by ion channeling techniques. Appleton, B.R.; Ritchie, R.H.; Biggerstaff, J.A.; Noggle, T.S.; Datz, S.; Moak, C.D.; Verbeek, H. (Oak Ridge National Lab., Tenn. (USA)). **63**: 513-520(Dec 1976).

From 2. international conference on surface effects in controlled fusion devices; San Francisco, California, USA (16 - 20 Feb 1976).

The unique constraints imposed on the interactions of energetic heavy ions with target atoms as a result of the channeling effect are utilized to investigate the phenomenon of radiative electron capture (REC) for 17 to 40 MeV oxygen ions. Measured cross-sections and widths of the REC radiation are compared to calculations made specifically for the channeling situation.

ATOMIC AND MOLECULAR PROPERTIES

REFER ALSO TO CITATION(S) 1174

1606 (AD-A—039793) **Vibrational spectra of transition metal hexafluoride crystals. III. Exciton band structures of MoF_6, WF_6, and UF_6. Technical report.** Bernstein, E.R.; Meredith, G.R. Apr 1977. Contract N00014-75-C-1179. 53p. NTIS PC A04/MF A01.

This paper presents the overall vibrational band structure of MF6 crystals based on the previously discussed two-particle, heavily doped mixed crystal, and neat crystal data in addition to dilute mixed crystal studies. Calculations of nu(2) and nu(5) bands based on a quadrupole-quadrupole intermolecular interaction model are determined to be in substantial agreement with the observations. The nu(1) bands are discussed in detail for a series of concentration studies, and it is possible to demonstrate that MoF_6 and WF_6 conform to the ideal mixed crystal model whereas crystals containing UF_6 do not. A consistent picture of gas-to-crystal shifts, resonance interactions, band shapes and structures, densities of exciton states, Fermi resonance, and simple multipolar interaction models emerges from these studies.

1607 (CONF-770643—(Absts.)) **Thirty-second symposium on molecular spectroscopy. Abstracts.** 1977. 196p. State University, Columbus, OH.

From 32. symposium on molecular spectroscopy; Columbus, Ohio, United States of America (USA) (13 Jun 1977).

The individual papers are abstracted separately for ERA. (JFP)

1608 (LBL—6275) **Molecular beam studies on multiphoton dissociation of polyatomic molecules.** Grant, E.R.; Schulz, P.A.; Sudbo, A.S.; Coggiola, M.J.; Shen, Y.R.; Lee, Y.T. Jun 1977. Contract W-7405-ENG-48. 21p. (CONF-770653—2). Dep. NTIS, PC A02/MF A01.

From International conference on multiphoton processes; Rochester, New York, United States of America (USA) (6 Jun 1977).

A study is made of the multiphoton dissociation of SF_6 and other molecules under the collisionless molecular beam conditions used routinely. The results are unambiguously consistent with a far more orderly picture of the excitation and dissociation process than that suggested previously. It is concluded that although the initial excitation is selective, nearly complete energy randomization must take place in the molecular vibrational degrees of freedom before decomposition. 26 references. (JFP)

1609 (UCRL—79550) **Identification of Rydberg states in the atomic lanthanides and actinides.** Paisner, J.A.; Solarz, R.W.; Worden, E.F.; Conway, J.G. 24 May 1977. Contract W-7405-ENG-48. 11p. (CONF-770713—2). Dep. NTIS, PC A02/MF A01.

From 3. international conference on laser spectroscopy; Jackson Hole, Wyoming, United States of America (USA) (4 Jul 1977).

The study of Rydberg spectra and ionization thresholds of ten lanthanides using several variations of time-resolved resonant multistep techniques is reported. The ionization limits for the lanthanides determined in this way show a systematic dependence on atomic number. A physical model explaining these results is presented. 16 references. (JFP)

1610 Channel-coupling theory of covalent bonding in H_2: A further application of arrangement-channel quantum mechanics. Levin, F.S.; Krueger, H. (Physics Department, Brown University, Providence, Rhode Island 02912). **16**: No. 3, 836-843(Sep 1977).

The dissociation energy D/sub e/ and the equilibrium proton-proton separation R/sub eq/ of H_2 are calculated using the methods of arrangement-channel quantum mechanics. This theory is the channel component version of the channel-coupling array approach to many-body scattering, applied to bound-state problems. In the approximation used herein, the wave function is identical to that of the classic Heitler-London-Sugiura valence-bond calculation, which gave D/sub e/ = 3.14 eV and R/sub eq/ = $1.65a_0$, values accurate to 34% and 17.8%, respectively. The present method yields D/sub e/ = 4.437 eV and R/sub eq/ $\simeq 1.42a_0$, accurate to 6.5% and 1%, respectively. Some implications of these results are discussed.

1611 Calculation of parity-nonconserving effects in the 6 ^{2}P/sub 1/2/-7 ^{2}P/sub 1/2/ forbidden M1 transition in thallium. Neuffer, D.V.; Commins, E.D. (Physics Department, University of California, Berkeley, California 94720). **16**: No. 3, 844-862(Sep 1977).

Calculations are presented of the E1 amplitude expected in the 6 ^{2}P/sub 1/2/-7 ^{2}P/sub 1/2/ forbidden M1 transition in Tl if parity conservation is violated in the neutral weak e-N interaction, as proposed in a number of gauge models, including that of Weinberg and Salam. Valence-electron wave functions are generated as numerical solutions to the Dirac equation in a modified Tietz central potential. These wave functions are used to calculate allowed E1 oscillator strengths, hfs splittings, and Stark E1 transition amplitudes. These results are compared with experiment and the agreement is generally good. The relativistic 6 ^{2}P/sub 1/2/-7 ^{2}P/sub 1/2/ M1 transition amplitude M is also calculated, and corrections due to interconfiguration mixing, Breit interaction, and hfs mixing are included. The result, M/sub theor/ = (-3.2 +- 1.0) x 10^{-5}vertical-bar evertical-barh/2m/sub e/c, is in agreement with the experimental value, M/sub expt/ = (-2.11 +- 0.30) x 10^{-5}vertical-bar evertical-barh/2m/sub e/c. The parity-nonconserving E1 amplitude E/sub PN/ is calculated, and a value for the circular dichroism, $\delta \simeq$ 2Im(E/sub PN,theo/)/M/sub expt/ = 2.6 x 10^{-3}, is obtained. Parity-nonconserving effects in other Tl transitions are discussed.

1612 Photoionization of vibrationally excited molecular hydrogen. Tai, H.; Flannery, M.R. (School of Physics, Georgia Institute of Technology, Atlanta, Georgia 30332). **16**: No. 3, 1124-1135(Sep 1977).

Cross sections for the photoionization of $H_2(X\ ^1\Sigma^+$/sub g/,v/sub i/) in vibrational levels v/sub i/ = 0—14 are determined for a range of photon energies by a two-center treatment in which the derived electronic matrix elements are averaged over the initial and final vibrational states of the molecule and the molecular ion. Very good agreement with available measurements for v/sub i/ = 0 is obtained. Cross sections for the full Franck-Condon array of accessible transitions H_2(v/sub i/) → H^+_2(v/sub f/) are also presented. In the energy range considered, when the $2p\sigma$/sub u/ dissociative state of H^+_2 is inaccessible, substantial contributions (up to 50% for v/sub i/ = 6—10) to the photoionization originate from H^+ atomic ions which are formed via transitions to the vibrational continuum associated with the $1s\sigma$/sub g/ state of H^+_2. Single-center and fixed-nuclei approximations which permit great simplification to the present treatment are also fully investigated.

1613 Geometry of the UO_2 molecule. Green, D.W.; Reedy, G.T.; Gabelnick, S.D. (Argonne National Lab., Ill. (USA)). **66**: No. 1, . 200(1977).

Conflicting data on the geometry of the UO_2 molecule may be resolved in favour of the linear molecule. Data supporting the non linear molecule are based on incorrect frequency assignments.

POSITRONIUM, MUONIUM, AND MUONIC AND MESIC ATOMS AND MOLECULES

1614 Analytic bound-state solutions in a relativistic two-body formalism with applications in muonium and positronium. Lepage, G.P. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). **16**: No. 3, 863-876(Sep 1977).

This work advocates the use in atomic physics of a new relativistic two-body formalism equal in rigor to the Bethe-Salpeter formalism and clearly superior to it in several respects. Outstanding among these is the existence of a Coulomb-like kernel for which the exact analytic solutions of the bound-state equations are known. These solutions are derived and applied in a calculation of the O (α^6m lnα^{-1}) contributions to hfs in muonium and positronium. Three previously unknown contributions are found. Theory and experiment are compared.

COLLISION PHENOMENA

1615 (AD-A—041444) **The photon scattering matrix element for transverse electric outgoing photons. Supplement.** Dogliani, H.O. Jun 1977. 27p. (USAFA-TR—77-7-Suppl). NTIS PC A03/MF A01.

The matrix element for photons scattering from bound K-shell electrons is presented. It is assumed that only magnetic multipoles are important and, hence, only transverse electric mode vector harmonic, outgoing photons are assumed.

1616 (LA—6691-MS) **Electron impact excitation of carbon and oxygen ions.** Magee, N.H. Jr.; Mann, J.B.; Merts, A.L.; Robb, W.D.

Apr 1977. Contract W-7405-ENG-36. 133p. Dep. NTIS, PC A07/MF A01.

This report is an attempt at a comprehensive compilation of currently available theoretical data on electron impact excitation of carbon and oxygen ions. It is designed to be of use primarily to theoretical atomic physicists, allowing them a broader than usual view of how various approximations compare. We do not attempt to place an estimate on the accuracy to which any of the collision strengths are known. The reader may obtain some idea of the accuracy from the spread in the calculations. Further, we do not evaluate rate coefficients or make any comparison with observed results. We do provide simple analytic fits to the data, where possible, thus allowing the reader to make comparison with observation or evaluate rate coefficients if he desires. The present data contains little about resonance effects, due to the difficulty of their presentation. It is possible that resonances could make a considerable change in the average collision strength near threshold, and this topic requires further study.

1617 Collision-induced ion-pair formation of the thallium halides TlF and Tl_2F_2. Parks, E.K.; Kuhry, J.G.; Wexler, S. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). **67**: No. 7, 3014-3028(1 Oct 1977).

Absolute cross sections have been determined for collision-induced ion-pair formation (polar dissociation) of TlF and Tl_2F_2 from collisions with Xe and Kr atoms. A crossed-beam method was used in which the Xe or Kr atoms were aerodynamically accelerated to energies up to 17 eV (in the laboratory frame). Time-of-flight mass spectrometry permitted the determination of partial cross sections for each positive and negative ion channel in the collision. With new values of the heats and entropies of formation of Tl_2Cl_2, Tl_2Br_2, and Tl_2I_2 the absolute cross sections for the previously reported reactions of the dimers $Xe(Kr)+Tl_2X_2 \rightarrow Xe(Kr)+Tl_2X^+ +X^-$ have been recalculated. The threshold behaviors of these reactions have also been analyzed in terms of the above power law, giving values of the power n in the range 2.1—2.7. Model calculations have been performed to determine bond energies of the $(Tl—X—Tl)^+$ and $(X—Tl—X)^-$ ions, which were used to determine theoretical thresholds for the formation of these ions. The difference between the experimental and theoretical thresholds then gives the internal excitation of the molecular ions at threshold (assuming the inert gas atom carries away negligible energy). Tl_2F^+, in particular, is formed at threshold with considerable internal excitation ($\sim$1.8 eV). The low cross sections for both TlF and Tl_2F_2 and the high internal excitation of Tl_2F^+ at threshold are consistent with a collision model in which only very dynamically constrained collisions result in the extraction of the light F^- ion from either TlF or Tl_2F_2.

1618 Charge transfer and Penning ionization of N_2, CO, CO_2, and H_2S in proton excited helium mixtures. Chen, C.H.; Judish, J.P.; Payne, M.G. (Health Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). **67**: No. 7, 3376-3381(1 Oct 1977).

In this work we report on studies of the kinetics of He—N_2 mixtures excited by a proton beam. The rate of charge transfer from both atomic and molecular helium ions to N_2 was studied using a time-resolved technique to measure the fluorescence of $N^+{}_2(B\ ^2\Sigma^+/sub\ u/\rightarrow X\ ^2\Sigma/sub\ g/)$. The population of $N^+{}_2(B^2\Sigma^+/sub\ u/)$ through a Penning ionization process from metastable helium atoms or molecules is observed, and the Penning ionization and charge transfer process which populates this state in a He—N_2 laser is discussed. The charge transfer rate constants of He^+—CO, He^+—CO_2, He^+—H_2S, and $He^+{}_2$—CO are also measured.

1619 Collisional line broadening using laser excitation and ionization. Nayfeh, M.H.; Hurst, G.S.; Payne, M.G.; Young, J.P. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). **39**: No. 10, 604-607(5 Sep 1977).

A laser excitation and ionization process is used to measure Cs-Ar interaction forces at long range. With energy densities of 1 J/cm^2, nonlinear excitation persists as far out as 70 A at one atmosphere of Ar. This method provides extreme sensitivity (even single absorption events can be measured) which allows absolute measurements on the very far wing where absorption or fluorescence becomes vanishingly small.

1620 Two-photon ionization of colliding atoms. Nayfeh, M.H. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). **16**: No. 3, 927-932(Sep 1977).

Semiclassical expressions of two-photon ionization of two colliding atoms are derived for a wide range of electromagnetic field intensity and detunings from the isolated atom line. The dependence of the ionization yield on the details of the interaction potential of the system is derived. This process promises an extremely sensitive method for studying line broadening on the far wing, especially when absorption or fluorescence becomes very weak.

1621 Electron transfer between He-like ions and He. Crandall, D.H. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). **16**: No. 3, 958-963(Sep 1977).

Single- and double-electron-transfer cross sections have been measured for B^{3+}, C^{4+}, N^{5+}, and O^{6+} in collision with He at velocities between 0.5 and 1.2 x 10^8 cm/sec. The single-electron-capture cross sections peak near 15 x 10^{-16} cm^2 for each case except C^{4+},where single capture is anomalously low. The double-capture cross sections are about 3 x 10^{-16} cm^2, except for B^{3+}, where the highest observed value is 1.5 x 10^{-16} cm^2. These measurements for B^{3+} and C^{4+} compare well with existing experiments and theory, except for C^{4+} single capture. Within the narrow range tested, C^{4+} and B^{3+} cross sections exhibit variation with velocity, but N^{5+} and O^{6+} cross sections remain constant.

1622 Mechanism of excitation of two-electron—one-photon K x rays in heavy-ion collisions. Greenberg, J.S.; Vincent, P.; Lichten, W. (Wright Nuclear Structure Laboratory, Yale University, New Haven, Connecticut 06520). **16**: No. 3, 964-974(Sep 1977).

The energy dependence of the cross sections for both the Kα (one-electron, one-photon) and Kαα (two-electron, one-photon) x-ray emissions for Ni-Ni collisions have been measured in the energy range 17.6—91.5 MeV. To account for these observations, we have extended the electron promotion model to the quantitative, ab initio calculation of double K-shell vacancies. The results furnish, for the first time, an independent test of both the Briggs-Macek formulation of the electron promotion model and the concept of velocity-dependent exit channels suggested by Fastrup et al. We also present, for the first time, a theory of the vacancy-sharing mechanism for double K-shell excitation in symmetric systems. The theoretical results are in quantitative agreement with experiment.

1623 Theoretical calculation of cross sections for rotational excitation in e-CO_2 scattering. Morrison, M.A.; Lane, N.F. (Theoretical Division T-12 (MS531), Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). **16**: No. 3, 975-980(Sep 1977).

Rotational excitation cross sections for e-CO_2 scattering in the energy range from 0.07 to 10.0 eV have been calculated using a coupled-channels procedure together with the adiabatic-nuclei (impulse) approximation. Results are presented for excitation from j = 0 to j' = 0, 2, and 4. Cross sections for j = 0 to j' = 2 in e-CO_2 scattering are compared with corresponding results for e-H_2 and e-N_2 collisions. The Born approximation for rotational excitation is examined for this problem and found to be unsatisfactory even at the lowest energies studied. Results for large initial rotational quantum number j are presented and discussed.

1624 Excitation of lithiumlike ions by electron impact. Gau, J.N.; Henry, R.J.W. (Department of Physics and Astronomy, Louisiana State University, Baton Rouge, Louisiana 70803). **16**: No. 3, 986-990(Sep 1977).

Collision strengths Ω for electron-impact excitation of C IV and Ar XVI are calculated in a five-state close-coupling approximation for energies up to 3 times threshold energy. These results are combined with previous calculations for NV and Ne VIII and isoelectronic fits are given for Ω (2s,2p) and Ω (2s,3l), where l = 0,1,2. In addition, polarization of the resonance 2s,2p line is calculated for Li-like C, N, Ne, and Ar up to 12 times threshold. A common feature is that the polarization changes from positive to negative at about 9 times threshold energy.

1625 Electron-molecule scattering theory: An R-matrix study of low-energy elastic e-N_2 collisions in the static-exchange approximation. Morrison, M.A.; Schneider, B.I. (Theoretical Division T-12, Mail Stop 531, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). **16**: No. 3, 1003-1012(Sep 1977).

The R-matrix formulation of electron-molecule collision theory is applied to low-energy e-N_2 scattering in the static-exchange approximation. Particular attention is given to the determination of basis sets for such L^2-variational calculations, and a study of important basis-set characteristics in the context of this collision problem is presented. Results for elastic e-N_2 collisions for scattering energies in the range from about 0.01 to 13.0 eV are reported. The importance of including long-range interactions is briefly discussed.

1626 Elctron impact excitation of the electronic states of N_2. I. Differential cross sections at incident energies from 10 to 50 eV. Cartwright, D.C.; Chutjian, A.; Trajmar, S.; Williams, W. (Laboratories Division, The Aerospace Corporation, El Segundo, California 90245). **16**: No. 3, 1013-1040(Sep 1977).

Normalized differential cross sections (DCS's) for the electron impact excitation of the lowest three singlet (a',a,w), and lowest five triplet (A,B,W,B',C) valence electronic states of N_2, and of the two ($3s\sigma/sub\ g/$) Rydberg states (E,a'') have been determined at seven incident electron energies ranging from 10 to 50 eV. These DCS's were obtained for the scattering-angle range 5° to 138° by analyzing electron energy-loss spectra in N_2 at a number of fixed scattering angles within that range. These data, which are the first that cover such a large incident energy and scattering-angle range,

for such a wide variety of final target states, show that each of the DCS's for the ten final target states falls into one of four classes. Since the initial molecular target state is a singlet, and none of the final states studied here is dipole allowed, these four classes are determined according to whether the final target state is triplet, singlet, parity-unfavored, or Rydberg in character. The DCS's for all the final target states change rapidly in shape as the incident electron energy is varied. Theoretical DCS's obtained from first-order perturbation models (Born-Ochkur and Ochkur-Rudge) agree poorly with the measured DCS's.

1627 Electron impact excitation of the electronic states of N_2. II. Integral cross sections at incident energies from 10 to 50 eV. Cartwright, D.C.; Trajmar, S.; Chutjian, A.; Williams, W. (Laboratories Division, The Aerospace Corporation, El Segundo, California 90245). **16**: No. 3, 1041-1051(Sep 1977).

Normalized integral cross sections for the electron impact excitation of the lowest three singlet (a',a,w) and lowest five triplet (A,B,W,B',C) valence electronic states of N_2, and of the two (3sσ/ sub g/) Rydberg states (E,a''), have been determined at seven incident electron energies ranging from 10 to 50 eV. These cross sections were obtained by integrating the differential cross sections reported in the preceding paper, over all scattering angles. The cross sections for excitation of the W, B', and a' states are considerably larger than previously estimated, that for excitation of the C state is in excellent agreement with previously reported values, while those for the A, B, and a states are smaller than previous results. Theoretical cross sections obtained with Born-type theories give integral cross sections that are in surprisingly good agreement for many of the excited states, but in a few cases (A,W,B',a') the theoretical cross sections are in poor agreement.

1628 Electron impact excitation of the electronic states of N_2. III. Transitions in the 12.5—14.2-eV energy-loss region at incident energies of 40 and 60 eV. Chutjian, A.; Cartwright, D.C.; Trajmar, S. (Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California 91103). **16**: No. 3, 1052-1060(Sep 1977).

Normalized absolute differential and integral cross sections for electron-impact excitation of five optically-allowed singlet states, two known triplet states, and two unknown triplet-like states of N_2, lying in the energy-loss range 12.5—14.2 eV, have been determined by analysis of electron energy-loss data at incident electron energies of 40 and 60 eV. The range of scattering angles considered in this work was 5° to 138°. The optically allowed transitions are to the b ^{1}Pi/sub u/, c ^{1}Pi/sub u/, c' $^1\Sigma$/sub u/$^+$, o ^{1}Pi/sub u/, and b' $^1\Sigma$/sub u/$^+$ states and the known triplet excitations are to the F ^{3}Pi/sub u/ and G ^{3}Pi/sub u/ states. Cross sections for excitation to two unidentified triplet-like states at 13.155 and 13.395 eV were also obtained from the data analysis. The relationship of the generalized oscillator strength for the dipole-allowed states obtained from the present measurements to known optical oscillator strengths is discussed.

1629 Projectile K x rays from Si^{12+} ions in the 1s2s $^3S_1$ metastable state incident on helium gas. Schiebel, U.; Doyle, B.L.; Macdonald, J.R.; Ellsworth, L.D. (Department of Physics, Kansas State University, Manhattan, Kansas 66506). **16**: No. 3, 1089-1092(Sep 1977).

The fractional population of Si^{12+} ions in the $^3S_1$ metastable state which is produced by the passage of 15—60-MeV Si ions through thin C and Au foils has been determined by measuring the x-ray yield from the spontaneous M1 decay of this state. This fraction (~ 24% for the thickest C foils and highest bombarding energies) increases linearly with increasing Si energy and is highly dependent on the foil thickness and material. This information has been used to obtain absolute cross sections for Si K x-ray production in Si^{12+} (1s2s $^3S_1$) → He collisions. From the results it is concluded that K x-ray emission predominantly occurs following 2 $^3S_1 \rightarrow 2\ ^3P_1$ excitation at the higher energies (~2 MeV/amu) and following outer-shell electron capture at the lower energies (~0.5 MeV/amu).

1630 Screening effect in Coulomb excitation of hydrogenic atoms by heavy projectiles. Losonsky, W. (Department of Physics, New York University, New York, New York 10003). **16**: No. 3, 1312-1314(Sep 1977).

The K-shell excitation of a hydrogenic atom by atomic projectiles is treated in the first plane-wave Born approximation including the screening effect of projectile electrons. Screening causes a large decrease in cross sections, in accordance with recently reported data of Hopkins et al.

1631 Comment on "Dependence of the Ta K x-ray energy on the mode of excitation". Freedman, M.S. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). **16**: No. 3, 1315-1316(Sep 1977).

A proposed interpretation in terms of outer-electron shakeoff is disputed.

1632 Reply to the Comment on "Dependence of the Ta K x-ray energy on the mode of excitation". Hahn, A.A.; Wang, K.; Boehm, F.; Henrikson, H.E.; Vogel, P. (California Institute of Technology, Pasadena, California 91125). **16**: No. 3, 1317(Sep 1977).

The difficulties in interpretation of the K x-ray shifts are acknowledged. A new experiment confirms, with higher accuracy, the previously reported data and excludes the possibility of a chemical shift.

GENERAL FLUID DYNAMICS

1633 (BNL—23147) "Relaxation" of initial probability density functions in the turbulent convection of scalar fields. Dopazo, C. 1977. Contract EY-76-C-02-0016. 48p. (CONF-770841—1). Dep. NTIS, PC A03/MF A01.

From Workshop on probability density function methods for turbulent flows; Aachen, F.R. Germany (29 Aug 1977).

The evolution of an intially binary (zero-unity) scalar field undergoing turbulent and molecular mixing is studied in terms of conservation equations for the probability density function of the scalar property. Attention is focused on the "relaxation" of the dynamic system to a state independent of the initial conditions. A few existing methods are discussed and evaluated, and a new mechanistic model is proposed. Classical iteration techniques are used to obtain an equation for the single point probability density and the unperturbed Green function. It is argued that it might be necessary to use the true Green function or perturbed propagator of the system to obtain the correct evolution of the probability density function. 10 figures.

1634 Numerical study of 2-D turbulence. Fornberg, B. (California Institute of Technology, Department of Applied Mathematics, Pasadena, California 91125). **25**: No. 1, 1-31(Sep 1977).

A simulation of 2-D turbulence in a square region with periodic boundary conditions has been performed using a highly accurate approximation of the inviscid Navier—Stokes equations to which a modified viscosity has been added. A series of flow pictures show how a random initial vorticity distribution quickly assumes a stringlike pattern which persists as the flow simplifies into a few "cyclones" or "finite area vortex regions". This trend towards well-defined large-scale structures can make it questionable if the 2-D flow should be described as "turbulent" and it casts some doubts on the concept of inertial range and the relevance of energy spectra. The change in appearance seems to be associated with a buildup of phase correlations in the Fourier representation of the vorticity field. During this initial buildup, the energy spectrum seems to follow a k^{-3}-law, but this behavior does not persist. If there is a power law for steady turbulence the results suggest that is more likely to be a k^{-4}-law.

SUPERFLUIDITY

1635 (PB—266872) Studies of supercritical helium-4 at low temperatures during heat flow including disordered boundary domain investigations. Progress report for 1976. Frederking, T.H.K.; Caspi, S.; Chang, Y.W.; Lee, J.Y. Nov 1976. 102p. (UCLA-ENG—76109). NTIS PC A06/MF A01.

The present investigations (following up on Rept. UCLA-ENG-7649) have been concerned with lambda-transition curves (during heat flow) above the thermodynamic critical pressure to avoid previous interpretation difficulties for literature data. Reference functions for single-phase He II and single-phase He I have been established to provide better assessment of two-phase data at supercritical pressures. A C-frame apparatus has been used to simulate for He I simulation of centrifugal buoyancy forces in rotating cooling systems. Further porous media investigations and type II superconductor-normal metal contact studies have been continued to get a better data base in the general area of composite superconductor - coolant interaction.

1636 Mobility of positive and negative ions in superfluid ^{3}He. Roach, P.D.; Ketterson, J.B.; Roach, P.R. (Department of Physics, Northwestern University, Evanston, Illinois 60201). **39**: No. 10, 626-629(5 Sep 1977).

The mobility of positive and negative ions has been studied as a function of temperature, electric drift field, and (in the A phase) magnetic-field direction in superfluid ^{3}He; the A-phase mobility is observed to be anisotropic with μ/sub perpendicularparallel/ for both positive and negative ions.

PARTICLE INTERACTIONS AND PROPERTIES - EXPERIMENTAL

ELECTROMAGNETIC INTERACTIONS

1637 Electroproduction of phi mesons. Dixon, R.; Galik, G.; Herzlinger, M.; Holmes, S.D.; Larson, D.; Pipkin, F.M.; Raither, S.; Silverman, A.; Wagner, R.L. (Laboratory of Nuclear Studies, Cornell University, Ithaca, New York 14853). **39**: No. 9, 516-519(29 Aug 1977).

We report measurements of the electroproduction of phi mesons from hydrogen at Q^2 values of 0.23, 0.43, and 0.97 GeV^2 with t varying from 0.125 to 1.3 GeV^2 at each Q^2 point. The data show no evidence for a Q^2 dependence of the slope of the t distribution; the forward cross section falls with increasing Q^2 as the square of the phi propagator; the decay angular distributions agree with the predictions of s-channel helicity conservation; and the ratio of the longitudinal to the transverse component increases linearly with Q^2.

1638 Dimuon and trimuon final states in deep inelastic muon scattering. Chang, C.; Chen, K.W.; Van Ginneken, A. (Michigan State University, East Lansing, Michigan 48824). **39**: No. 9, 519-523(29 Aug 1977).

32 dimuon and 11 trimuon events are observed in deep inelastic muon interactions at 150 GeV. The rate of diumuon production is greater than 5×10^{-4} that of inclusive muon scattering. High-inelasticity trimuons occur at a rate one order of magnitude lower. These events are more numerous and the extra muons have qualitatively different production characteristics than muons expected from conventional sources.

WEAK INTERACTIONS

1639 Normalized small-y cross sections for neutrinos and antineutrinos at high energy. Barish, B.C.; Bartlett, J.F.; Bodek, A.; Brown, K.W.; Buchholz, D.; Chu, Y.K.; Sciulli, F.; Siskind, E.; Stutte, L.; Fisk, H.E.; Krafczyk, G.; Nease, D.; Fackler, O. (California Institute of Technology, Pasadena, California 91125). **39**: No. 12, 741-744(19 Sep 1977).

We present results on flux-normalized neutrino and antineutrino cross sections near $y = 0$ from data obtained in the Fermilab narrow-band beam. We conclude that they are consistent with rising linearly with energy over the range $45 <$ or $=$ E/sub ν/GeV. The separate averages of ν and nu-bar each measured to 4%, are equal to well within the errors. The best fit for the combined data gives $\sigma_0/E = (0.719 \pm 0.035) \times 10^{-38}$ cm^2/GeV at an average E/sub ν/of 100 GeV.

1640 Observation of a resonance in e^+e^- annihilation just above charm threshold. Rapidis, P.A.; Gobbi, B.; Lueke, D.; Barbaro-Galtieri, A.; Dorfan, J.M.; Ely, R.; Feldman, G.J.; Feller, J.M.; Fong, A.; Hanson, G.; Jaros, J.A.; Kwan, B.P.; Lecomte, P.; Litke, A.M.; Madaras, R.J.; Martin, J.F.; Mast, T.S.; Miller, D.H.; Parker, S.I.; Perl, M.L.; Peruzzi, I.; Piccolo, M.; Pun, T.P.; Ronan, M.T.; Ross, R.R.; Sadoulet, B.; Trippe, T.G.; Vuillemin, V.; Yount, D.E. (Stanford Linear Accelerator Center and Department of Physics, Stanford University, Stanford, California 94305). **39**: No. 9, 526-529(29 Aug 1977).

We observe a resonance in the total cross section for hadron production in e^+e^- annihilation at a mass of 3772 ± 6 MeV/c^2 having a total width of 28 ± 5 MeV/c^2 and a partial width to electron pairs of 370 ± 90 eV/c^2.

1641 Measurement of the branching ratio Γ (K/sub L/ → $\pi^+\pi^-$)/Γ (K/sub L/ → all). DeVoe, R.; Cronin, J.W.; Frisch, H.J.; Grosso-Pilcher, C.; Linsay, P.; Shochet, M.J.; Moffett, D.R. (The Enrico Fermi Institute, University of Chicago, Chicago, Illinois 60637). **16**: No. 3, 565-567(1 Aug 1977).

We have measured the branching ratio Γ (K/sub L/ → $\pi^+\pi^-$)/Γ (K/sub L/ → all) to be $(2.01 \pm 0.09) \times 10^{-3}$. This value is in good agreement with other recent determinations of this branching ratio and yields a value for the CP-violating parameter eta/sub + -/ of $(2.25 \pm 0.05) \times 10^{-3}$.

STRONG BARYON-INDUCED INTERACTIONS

1642 Spin-spin interactions in high-transverse momentum elastic p-p scattering. O'Fallon, J.R.; Ratner, L.G.; Schultz, P.F.; Abe, K.; Fernow, R.C.; Krisch, A.D.; Mulera, T.A.; Salthouse, A.J.; Sandler, B.; Terwilliger, K.M.; Crabb, D.G.; Hansen, P.H. (Argonne Universities Association and Argonne National Laboratory, Argonne, Illinois 60439). **39**: No. 12, 733-736(19 Sep 1977).

We measured $d\sigma/dt$ for $p + p \rightarrow p + p$ at 11.75 GeV/c using the zero-gradient synchrotron 70% polarized-proton beam and a 65% polarized-proton target. We obtained the spin-orbit asymmetry parameter A and the spin-spin correlation parameter C/sub n n/ out to P/sub transverse/$^2 = 4.2$ $(GeV/c)^2$. We found that A drops smoothly towards zero, but that C/sub n n/ increases abruptly near P/sub transverse/$^2 = 3.6$ $(GeV/c)^2$, where the exp(-1.4P/sub transverse/^{2}) component of elastic scattering becomes dominant. This suggests that large-P/sub transverse/^{2} "hard" elastic scattering may occur mostly when the two proton spins are parallel.

1643 Search for quarks produced with large transverse momentum in 400-GeV proton-nucleus collisions. Antreasyan, D.; Cocconi, G.; Cronin, J.W.; Frisch, H.J.; Olive, K.; Shochet, M.J.; Kluberg, L.; Mueller, J.; Piroue, P.A.; Sumner, R.L. (The Enrico Fermi Institute, University of Chicago, Chicago, Illinois 60637). **39**: No. 9, 513-515(29 Aug 1977).

We have searched for charge-1/3 and charge-2/3 particles produced with large transverse momentumin 400-GeV proton-Cu collisions. 4.9×10^4 positive and 1.5×10^4 negative unit-charge particles provided the normalization; no fractionally charged particles were found. The 90%-confidence-level upper limits for the invariant production cross sections per nucleon for positive and negative charge-1/3 particles are 5.1×10^{-39} and 8.8×10^{-39} cm^2 GeV^{-2}, respectively; for charge-2/3 particles the respective limits are 1.3×10^{-39} and 2.2×10^{-39} cm^2 GeV^{-2}.

1644 Direct e^+e^- pair production by 300-GeV/c protons in neon. Loveless, R.J.; Erwin, A.R.; Harvey, E.H.; Mapp, J.; Thompson, M.A. (Department of Physics, University of Wisconsin, Madison, Wisconsin 53706). **16**: No. 3, 546-548(1 Aug 19[illegible]).

We report direct e^+e^- pair production by 300-GeV/c protons in the Fermilab 30-in. bubble chamber filled with 31% molar mixture of neon in hydrogen. We find 310 direct pairs for a cross section $\sigma = 12.0 \pm 0.6$ mb, in good agreement with quantum-electrodynamic calculations. Both the momentum distribution and the momentum asymmetry distributions of our direct pairs also agree well with theory.

1645 High-P/sub transverse/^{2} p-p elastic scattering in pure initial spin states. Miettinen, H.E.; Abe, K.; Fernow, R.C.; Krisch, A.D.; Mulera, T.A.; Salthouse, A.J.; Sandler, B.; Terwilliger, K.M.; O'Fallon, J.R.; Ratner, L.G.; Schultz, P.F. (Nordita, DK 2100 Copenhagen, Denmark). **16**: No. 3, 549-552(1 Aug 1977).

We measured the cross section for proton-proton elastic scattering at 11.75 GeV/c using the Zero Gradient Synchrotron 52% polarized proton beam and a 60% polarized proton target. We measured $d\sigma/dt$ (ij) in the initial spin states perpendicular to the scattering plane in the range P/sub transverse/$^2 = 2.0$—3.6 $(GeV/c)^2$. We found that the asymmetry parameter A decreases smoothly with increasing P/sub transverse/^{2} in this range, and that the spin-spin correlation parameter C/sub n n/ may have a minimum near P/sub transverse/$^2 = 3$ $(GeV/c)^2$.

1646 Extraction of average multiplicities of high-energy off-mass-shell $\pi\pi$ and Kπ scattering. Erwin, J.; Kass, R.D.; Klems, J.H.; Ko, W.; Lander, R.L.; Pellett, D.E.; Yager, P.M.; Alston-Garnjost, M. (Department of Physics, University of California, Davis, California 95616). **16**: No. 3, 553-557(1 Aug 1977).

Inclusive $\Delta^{++}(1236)$ and Λ^0 production in π^+ p and pp interactions is examined in terms of a one-meson-exchange model. We find inclusive Δ^{++} production to be consistent with one-pion exchange, and if one demands a gap of at least one unit of rapidity between the Λ^0 and its recoiling mass, inclusive Λ^0 production is consistent with one-kaon exchange. The average charge multiplicity, <N/sub CH/>, recoiling from the Δ^{++} and Λ^0 is studied as a function of missing mass M^2 for both π^+p and pp interactions.

1647 Transverse-momentum properties of multipion systems produced in high-energy collisions. Stix, P.; Bromberg, C.; Ferbel, T.; Jensen, T.; Slattery, P. (University of Rochester, Rochester, New York 14627). **16**: No. 3, 558-564(1 Aug 1977).

The results of an investigation of the correlation between the mass (M) and the transverse momentum (p/sub T/) of multipion systems produced in pp collisions at 102 and 400 GeV/c indicate that, for fixed M, p/sub T/ distributions are only weakly dependent on the incident energy, as well as on the charge and multiplicity of the produced system. The dependence of <p/sub T/> on M is much stronger and is similar to that measured for discrete hadronic states.

STRONG MESON-INDUCED INTERACTIONS

REFER ALSO TO CITATION(S) 1712

1648 (SLAC-PUB—1599) Quantum numbers and decay modes of the resonances psi(3095) and psi(3684). Boyarski, A.M.; Breidenbach, M.; Bulos, F. Jun 1975. 21p. (CONF-750654—59). Dep. NTIS, PC A02/MF A01.

From High energy particle physics divisional conference of EPS; Palermo, Italy (23 Jun 1975).

The results obtained from an extensive analysis of decays of the psi particles recorded by the solenoidal magnetic detector are

summarized. Many of these results are preliminary. 25 references. (JFP)

1649 Total secondary-particle multiplicity distributions of π^-p interactions at 5—40 GeV/c. Amaglobeli, N.S.; Budagov, Y.A.; Vinogradov, V.B.; Volod'ko, A.G.; Dzhelepov, V.P.; Lomakin, Y.F.; Rumyantsev, V.S.; Salukvadze, R.G.; Flyagin, V.B.; Shandor, L.; Shoshiashvili, S.S. (Joint Institute for Nuclear Research). **25**: No. 2, 182-185(Feb 1977).

The results of an analysis of the total secondary-particle multiplicity distributions of π^-p interactions at 5—40 GeV/c are presented. A new formula capable of representing all the investigated distributions is proposed. It is shown that the distribution with respect to the multiplicity n'=n-2 of "truly produced" particles satisfies the KNO scaling hypothesis in the energy range examined, and a simple analytic formula for the universal KNO scaling function is proposed.

1650 Correlations of charged particles and γ quanta in semi-inclusive π-p interactions at 40 GeV/c. Dubna—Moscow—Tbilisi Collaboration. (JINR). **25**: No. 2, 186-188(Feb 1977).

Experimental data on the two-particle correlation functions R/sup(n)/(y_1*,y_2*) and C/sup(n)/(y_1*, y_2*) for γch, $\gamma\pi^-$, $\gamma\pi^+$, and $\gamma\gamma$ systems in semi-inclusive π-p interactions at 40 GeV/c are presented. It is shown that R/sup(n)/(0, 0) and C/sup(n)/(0, 0) vanish (within two standard errors) for various secondary-charged-particle multiplicities. A particle-identity effect is observed in the azimuthal correlations of $\gamma\gamma$ pairs at Phi→0.

1651 Investigation of certain inclusive distributions of hyperons and K^0_1 mesons in π^- ^{12}C collisions at 40 GeV/c. Dubna—Sofia—Tbilisi Collaboration. (JINR). **25**: No. 2, 188-191(Feb 1977).

Results are presented of investigations of certain inclusive spectra of Λ hyperons and K^0_1 mesons produced in π^- ^{12}C interactions at 40 GeV/c. The distributions for the π^- ^{12}C interactions are compared with the corresponding distributions for π^-p collisions. It can be concluded that the carbon nucleus changes the momentum and angular characteristics of the Λ and K^0_1 particles only insignificantly.

1652 Distributions with respect to transverse momentum in the inclusive reaction $K^+p\rightarrow K^0+X$ in the primary-momentum interval from 5 to 32 GeV/c, and in the reaction $K^+p\rightarrow\pi^-+X$ from 8.2 to 32 GeV/c. France—Soviet Union and CERN—Soviet Union Collaboration. (CERN). **25**: No. 2, 191-194(Feb 1977).

The spectra with respect to transverse momenta were investigated in the inclusive reaction $K^+p\rightarrow K^0+X$ at primary momenta 5, 8.2, 16, and 32 GeV/c and in the reaction $K^+p\rightarrow\pi^-+X$ at 8.2, 16, and 32 GeV/c. It is shown that the inclusive spectra are well described by a Bose-Einstein distribution. A strong correlation has been observed between the values of the effective parameter T and the reduced longitudinal momentum x of the inclusive particle. A dependence of the parameter T on the primary momentum and on the type of inclusive particle is established.

1653 Investigation of the reaction $\pi^-p\rightarrow$etan at momenta up to 40 GeV/c. Apel, W.D.; Bertolucci, E.; Bushnin, Y.B.; Vincelli, M.L.; Grachev, M.I.; Donskov, S.V.; Givoletti, M.; Johnson, R.; Inyakin, A.V.; Kachanov, V.A.; Kittenberger, W.; Krasnokutskii, R.N.; Leder, G.; Lednev, A.A.; Manelli, I.; Mikhailov, Y.V.; Mueller, H.; Oberparleiter, R.; Pernika, M.; Prokoshkin, Y.D.; Pierazzini, G.M.; Sergiampietri, F.; Sigurdsson, G.; Scribano, A.; Thys, A.; Franceschini, R.; Schinzel, D.; Schneider, H.; Staudenmaier, H.M.; Steuer, M.; Shuvalov, R.S. (Joint Experiment of the Institute of High Energy Physics (Serpukhov, USSR) and the European Organization for Nuclear Research (Geneva, Switzerland)). **25**: No. 2, 194-197(Feb 1977).

Cross sections for the reaction $\pi^-p\rightarrow$etan are measured at the momenta 15 and 40 GeV/c. About 30,000 events are recorded. A hodoscope spectrometer on line with a computer was used to detect γ pairs from eta-meson decays. The differential cross section decreases exponentially with increasing t, the 4-momentum transfer squared, and for $-t>2$ (GeV/c)^2 it is less than 1 nb/(GeV/c)^2. The A_2 trajectory is determined; it has a linear form α/sub A/2(t) $=0.45+0.7t$ in the region $0<-t9$ or ≈1 (GeV/c)^2.

1654 Polarization in elastic π^+-, K^+-meson and proton scattering by protons at momentum 45 GeV/c. Derevshchikov, A.A.; Matulenko, Y.A.; Meshchanin, A.P.; Nurushev, S.B.; Saraikin, A.I.; Siksin, V.V.; Smirnov, E.V.; Solov'yanov, V.L.; Bruneton, C.; Bystricky, J.; Gaidot, A.; Deregel, J.; Ducros, I.; Khantine-Langlois, F.; Cozzika, G.; Lehare, F.; de Lesquen, A.; Merlo, J.; Miyashita, S.; Movchet, J.; Pierrard, J.; Raoul, J.; Rossum, L.V.; Kazarinov, Y.M.; Kazarinov, M.Y.; Potashnikova, I.K.; Strakhota, I.; Khachaturov, B.; Kanavets, V.P. (Institute of High Energy Physics, Serpukhov, USSR). **25**: No. 2, 198-200(Feb 1977).

The polarization parameter P is measured in elastic π^+p, K^+p, and pp scattering at the momentum 45 GeV/c for 4-momentum transfers from -0.08 to -1.1 (GeV/c)^2 for pp scattering and from -0.08 to -0.9 (GeV/c)^2 for π^+p and K^+p scattering. The energy dependence of the polarization P (t) in π^+p and K^+p scattering above 6 GeV/c is consistent with the interference between the Pomeron and the Reggeon. On the other hand, the polarization in elastic pp scattering decreases faster than is predicted by the conventional Regge-pole model. This result may be due to interference between the Pomeron amplitudes with and without change of helicity, thus resulting in a negative polarization.

PARTICLE INTERACTIONS AND PROPERTIES - THEORETICAL

GENERAL

1655 One-gluon-exchange quark scattering and large-p/sub T/ inclusive data. Cutler, R.; Sivers, D. (High Energy Physics Division, Argonne National Laboratory, Argonne, Illinois 60439). **16**: No. 3, 679-689(1 Aug 1977).

Calculations based on the idea of asymptotic freedom enable one to estimate an effective quark-gluon coupling from experimental observations of scaling violations in deep-inelastic scattering, from Okubo-Zweig-Iizuku-rule—forbidden decays of the psi and the psi', and from corrections to the parton model for σ ($e^+e^-\rightarrow$ hadrons). These estimates then make it possible to normalize the one-gluon-exchange Born term for quark-quark elastic scattering and, within the context of hard-scattering models for hadronic collisions, obtain a lower limit on large-p/sub T/ inclusive cross sections. The theoretical lower limit for the cross section is found to be slightly below CERN ISR data on $pp\rightarrow\pi^0X$ at $\sqrt{s}=53$ GeV, p/sub T/ > or = 6 GeV. Further measurements at the CERN ISR or at projected new accelerators may be sensitive to the presence of this mechanism. Such measurements will be extremely important in testing the underlying unity of diverse reactions within the general framework of quark-gluon dynamics. They may also provide the most direct determination of the effective hadronic coupling constant.

1656 Normalization of the triple-Pomeron coupling. Frazer, W.R.; Paige, F.E. (Department of Physics, B-019 University of California, San Diego, La Jolla, California 92093). **16**: No. 3, 913-915(1 Aug 1977).

Various papers on the Gribov Reggeon calculus use various normalization conventions for the triple-Pomeron coupling constant. These normalizations are compared, and some errors are corrected.

1657 Realization of Nambu mechanics: A particle interacting with an SU(2) monopole. Hirayama, M. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). **16**: No. 2, 530-532(15 Jul 1977).

We study the system of a particle bearing isospin degrees of freedom interacting with an SU(2) 't Hooft-Polyakov monopole. We show that its equation of motion can be cast into the form of Nambu's generalized mechanics.

ELECTROMAGNETIC INTERACTIONS

REFER ALSO TO CITATION(S) 1672

1658 Pair creation by photon-photon scattering in a strong magnetic field. Ng, Y.J.; Tsai, W. (The Institute for Advanced Study, Princeton, New Jersey 08540). **16**: No. 2, 286-294(15 Jul 1977).

The fourth-order forward photon-photon scattering in an external magnetic field is considered by using an explicit "momentum" representation of the electron propagator. The optical theorem is then used to obtain the total pair-creation cross sections. Explicit results are obtained for the zero-field limit and for the case when both photon momenta are parallel to the magnetic field.

WEAK INTERACTIONS

1659 Test of flavor-changing neutral currents from elastic neutrino- and antineutrino-proton scattering. Kang, K.; Kim, J.E. (Department of Physics, Brown University, Providence, Rhode Island, 02912). **16**: No. 3, 568-571(1 Aug 1977).

The general form of the neutral currents satisfying "natural" conservation of strangeness is considered for the general class of SU(2) x U(1) gauge models and is tested against the existing data on elastic νp and nu-barp scattering. The existence of charm-changing neutral currents seems to be a possibility. In addition, we predict the ratio of the charged-current ν and nu-bar cross sections R/sub CC/ = σ/sub nu-barν/ to be less than about 0.8 at high energies.

1660 Antineutrino anomalies and right-handed currents. Albright, C.H.; Shrock, R.E. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). **16**: No. 3, 575-596(1 Aug 1977).

We analyze the predictions of several gauge-theory models for inclusive charged-current antineutrino reactions on isoscalar, proton, and neutron targets. In particular, we calculate y and W

distributions, average y, B parameters, and cross-section ratios. Gauge models incorporating right-handed quark transitions of the type u → b and d → x are considered, where the heavy quarks b and x have charges -1/3 and -4/3, respectively. The effects of varying both the quark masses and the physical thresholds are examined. Experimental cuts and flux-averaging, where appropriate, are applied to the model predictions for the Fermilab counter and bubble-chamber experiments. We find that with reasonable choices of parameters, five- or six-quark models with valence-strength right-handed currents can fit most of the present experimental data to within one-standard-deviation accuracy.

1661 Second-class currents in weak pion production. Monsay, E.H. (Princeton University, Princeton, New Jersey 08540). **16**: No. 3, 609-621(1 Aug 1977).

Effects arising from a possible second-class axial-vector current are considered for the reactions $\nu p \rightarrow \mu^- p\pi^+$ and nu-barn → / sup mu+/$n\pi^-$ in the (3,3) -resonance region. In the absence of second-class contributions, certain characteristic terms in the differential cross section must be identical in magnitude for the two mirror reactions. The experimental observation of differences would signal, in a model-independent way, the existence of second-class contributions. To assess how large the effects might be, the resonance-enhances, generalized Born approximation is adopted, and it is found that the signal could be quite substantial if the second-class coupling is as large as indicated by recent nuclear β-decay experiments. Second-class contributions also alter the expectations for other correlation terms and for the total cross section. All of these effects are analyzed for a range of values of the second-class coupling parameter.

1662 Structure functions of spin-dependent deep-inelastic scattering in the cavity approximation to the MIT bag model. Hughes, R.J. (Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). **16**: No. 3, 622-629(1 Aug 1977).

The structure functions of spin-dependent deep-inelastic electron-proton scattering are calculated within the cavity approximation to the MIT bag model of hadrons. As expected, Bjorken scaling is obtained. The model predicts two nontrivial structure functions, unlike simple parton models. It is argued that this behavior is associated with the explicit quark confinement of the bag model. The general features of the structure functions are discussed and the shortcomings of the approximations used are explained. The two sum rules obtained from previous light-cone analyses are verified.

1663 How can we verify the weak selection rules of the new particles. Nachtmann, O.; Pais, A. (Rockefeller University, New York, New York 10021). **16**: No. 3, 630-645(1 Aug 1977).

Consequences of the weak selection rules for the new particles (charm, heavy leptons) are discussed for inclusive measurements. The quantities studied are ratios of mean numbers and of mean energies of π^+ versus π^-, K-bar^0 versus K^-, and K^0 versus K^+, both in e^+e^- annihilation and in ν and nu-bar reactions. For e^+e^- annihilation, we also give bounds on π^{+-} energies in terms of the total energy available. The results hold with arbitrary cuts on π's and K's. Some results for e^+e^- annihilation do not require full lepton detection, others do. For neutrino reactions, we also give bounds on the total number of kaons in terms of the number of observed K/sub S/ → $\pi^+\pi^-$. Special care is taken to fully include the complications arising from the isospin-violating decays $D^* \rightarrow D + \pi$ (or γ) and from the frequently occurring inseparability of production and decay mechanisms. Three main classes of events are considered, namely tagged decays in e^+e^- annihilation, single-fixed-sign-lepton production in e^+e^- annihilation, and prompt dilepton events in ν and nu-bar reactions.

1664 Decay $\pi^0 \rightarrow e^+e^-$. Herczeg, P. (Theoretical Division, Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). **16**: No. 3, 712-719(1 Aug 1977).

Phenomenological aspects of the decay $\pi^0 \rightarrow e^+e^-$ are discussed in the presence of a general neutral-current interaction. It is pointed out that a large CP-violating amplitude, of the order of magnitude of the CP-conserving one, is not ruled out in this decay by a present data.

1665 Limits on a π-μ atom anomaly. Staffin, R. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). **16**: No. 3, 726-731(1 Aug 1977).

The decay rate of K^0/sub L/ into $\pi\mu$ atoms provides a test for the existence of a possible short-range anomalous interaction between the pion and muon. For an elastic interaction, the effect would show up in the $\pi\mu$ wave function of the Coulomb bound state, and we examine mechanisms that could alter the wave function at the origin. An inelastic interaction that could lead to depletion of $\pi\mu$ atoms through the Konopinski-Mahmoud—allowed transition $\pi^+\mu^- \rightarrow \pi^-e^+$ is also considered. Limits on these interactions are computed from precise atomic measurements of energy levels in muonic atoms and from the measured muon g-2 value and capture rates. These limits are then related to recent observations on the formation of $\pi\mu$ atoms in K/sub L/^{0} decay.

1666 Lepton spectrum in the semileptonic weak decays of charmed mesons. Wilson, W.J. (University of Minnesota, School of Physics and Astronomy, Minneapolis, Minnesota 55455). **16**: No. 3, 742-745(1 Aug 1977).

If we assume that the semileptonic decays of the charmed D mesons are dominated by the two channels D → Klν and D → K*lν, then, by measuring the average energy of the decay lepton, we can put an upper bound on the ratio R = Γ (D → Klν)/Γ (D → K*lν). Using a limited quantity of data from DESY, we find R 9 or ≈ 0.7.

1667 Multihadron semileptonic decays of charmed mesons. Barger, V.; Gottschalk, T.; Phillips, R.J.N. (University of Wisconsin, Physics Department, Madison, Wisconsin 53706). **16**: No. 3, 746-771(1 Aug 1977).

We discuss and illustrate the effects of hadron multiplicity in the semileptonic decay of charmed mesons. Using specific models for the decay matrix elements, and for the production process where necessary, we evaluate the consequences of multiple-hadron decay products on distributions of practical interest: (i) energy distributions in e^+e^- colliding beam measurements, (ii) energy distributions in leptoproduction, (iii) transverse-momentum distributions in leptoproduction, photoproduction, and hadroproduction, and (iv) Kl invariant-mass distributions and other two-particle correlations. Theoretical estimates suggest that D → Klν and D → K*lν modes, in similar proportion, approximately saturate the inclusive semileptonic rate; this is consistent with existing data. Effects of hadronic form factors on decay rates and distributions are considered. Calculated acceptance corrections for undetected slow secondary muon in neutrino dimuon experiments increase the rates to 2—3% of charged-current events.

1668 Comment on the Glashow-Weinberg theorem. Kang, K.; Kim, J.E.; Nabavi, R. (Department of Physics, Brown University, Providence, Rhode Island 02912). **16**: No. 3, 911-912(1 Aug 1977).

It is shown that the Glashow-Weinberg theorem for the strangeness-changing neutral current is valid up to order G/sub F/α even if there are Q = 2/3 or Q = -4/3 flavor-changing neutral currents.

1669 Whatsivcan we learn from $e^+e^- \rightarrow U^+U^- \rightarrow \mu^{+-}$ hadrons+neutrinos. Hagiwara, T.; Pi, S.; Sanda, A. (The Rockefeller University, New York, New York 10021). **106**: No. 1, 134-170(Jul 1977).

We have made a systematic study of the process $e^+ + e^- \rightarrow U^+ + U^- \rightarrow \mu^{+-}$ (direct single muon production process or DSM), to determine how information on the weak interaction governing the U decay can be obtained. We have found the following: (1) The muon-energy distribution for the process $e^+ + e^- \rightarrow \mu^{+-}$ can be studied to extract the value of the Michel parameter rho for the decay U→μ+ neutrinos. (2) The muon-angular distribution for the same process can be studied to obtain information on the U^+U^- γ-coupling. (3) Among many U-decay channels contributing to the process $e^+ + e^- \rightarrow \mu^{+-}$ minus-or-plus+ neutral particles, decays $U^- \rightarrow \nu$/sub U/+π^- and $U^- \rightarrow \nu$/sub U/+rho$^-$ can be separated from the rest since these decay modes result in considerably different pion-energy distributions. The contributions of $U^- \rightarrow \nu$/sub U/+π^- and $U^- \rightarrow \nu$/sub U/+rho$^-$ in above process can be studied to obtain further information on the nature of the weak current. There are quite a few different ways in which DSM can be studied. Many are complimentary to each other and we except that such studies will lead to a good understanding of the weak decays of U^{+-} Lagrange equations postulated in the first paper of this series for the case when they are regular, namely, when they are simple equivalence transformations of the conventional Lagrange equations. We first introduce a generalization of the action principle capable of inducing the generalized as well as the conventional equations. In this way we establish that the former equations are "bona fide" analytic equations. Finally, as our most general analytic framework for the case of unconstrained field equations, we work out the necessary and sufficient condition for the existence of ordered direct analytic representations of quasi-linear systems in terms of the generalized analytic equations and study their relationship to the conventional representations.

1670 $e^+ + e^- \rightarrow U^+ + U^- \rightarrow \mu^{-+}$/sup [e +- /+neutrinos: general considerations. Pi, S.; Sanda, A.I. (Rockefeller University, New York, New York 10021). **106**: No. 1, 171-204(Jul 1977).

We present a general differential cross section for the process $e^+ + e^- \rightarrow \gamma \rightarrow U^+ + U^- \rightarrow \mu^- + \nu$/sub U/+$\nu$/sub μ/+e^+ +nu-bar/sub U/+ν/sub e/. Our results hold for V, A, S, P, T couplings and do not depend on the μe universality assumption. Dependences on arbitrary beam polarizations, final state electron, and muon longitudinal polarizations, and final state electron and muon masses have been included. An analytic expression for dσ/dE/sub e/dE/sub μ// sub d/cos θ/sub μ/has been obtained. We show that it is possible to

investigate the leptonic decay of U to the same level as that for the muon decay.

1671 Effects of neutral weak currents in e^+-e^- annihilation. Pocsik, G. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). **105**: No. 2, 259-275(Jun 1977).

The effects of neutral weak currents are discussed in e^+e^- annihilation into final states such as $\mu^+\mu^-$, e^+e^-, $\pi^+\pi^-$, many hadrons and also in the one particle inclusive production. According to current gauge models these weak effects which are manifested as various asymmetries, turn out to be around 10% in the energy range of PEP and PETRA. In identifying weak effects polarized incident beams are advantageous, in particular, the longitudinally polarized beams select parity violating asymmetries.

1672 Production of a W boson with an anomalous electric quadrupole moment in leptonic processes. Koval'chuk, V.A. (Khar'kov Physico-technical Institute, Ukrainian Academy of Sciences). **25**: No. 2, 204-206(Feb 1977).

The differential cross sections of the processes ν/sub μ//sub [Z $\rightarrow$Z-/+W$^+$ and $\mu^+ + Z \rightarrow Z +$nu-bar/sub μ//sub [W+/, in which an intermediate vector W boson is produced when neutrinos or muons are scattered by nucleons and nuclei, are calculated with allowance for the anomalous quadrupole moment λ of the W boson. The asymptotic behavior of the total cross sections of these processes is investigated (in the case of scattering by protons). The total cross sections for W-boson production with allowance for the anomalous electric quadrupole moment λnot =0 increase linearly with increasing s, but if λ=0 the cross sections increase more slowly, as $\ln^3(s/m^2)$.

1673 Some weak-interaction effects in the $e^+e^-\rightarrow$hadrons annihilation. Smilga, A.V. (Moscow Physico-technical Institute). **25**: No. 2, 249-251(Feb 1977).

The Weinberg model is used to calculate the polarization, angular distribution, and charge asymmetry in the e^+e^- annihilation into hadrons.(AIP)

1674 P-odd asymmetry in the annihilation process $e^+e^-\rightarrow\mu^+\mu^-$ and the sign of the constant G. Khristova, E.K. (Joint Institute for Nuclear Research). **25**: No. 2, 251-252(Feb 1977).

It is demonstrated theoretically that it is possible to determine the sign of the fundamental weak interaction constant if weak neutral currents exist for charged leptons.(AIP)

STRONG INTERACTIONS, GENERAL

1675 Possible new species of quarks and hadrons. Wilczek, F.; Zee, A. (Joseph Henry Laboratories, Princeton University, Princeton, New Jersey 08540). **16**: No. 3, 860-868(1 Aug 1977).

Assuming that the strong interactions are mediated by a color-SU(3) gauge theory, we consider unusual possibilities for the constituents. The simplest possibility, "shiny" quarks, is that some new quarks are not triplets under color. We analyze the production and signatures for this possibility. Special attention is drawn to the spectroscopy of hadrons containing shiny quarks, some of which are absolutely stable. A more complicated (and possibly deeper dynamically) idea is that of "echo" quarks. These result when the unbroken color SU(3) arises from the breakdown of a larger SU(3) x SU(3) gauge symmetry. The dynamical motivations for this speculation and the distinctive phenomena that follow from it are analyzed. We find that there is no evidence against echo quarks of quite low mass ($>$ or $\approx$ 2 GeV), which might be produced at present-day accelerators.

1676 Planar bootstrap without the dual-tree approximation. Balazs, L.A.P. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). **16**: No. 3, 885-895(1 Aug 1977).

We consider a dual multiperipheral model at and near t = 0, and argue that the usual imposition of a Regge-cluster finite-energy sum rule is probably redundant. Instead we require that the $\pi\pi$ amplitude satisfy the Adler PCAC (partial conservation of axial-vector current) condition and crossing near s = t = 0. We then set up a specific Pade approximation to the multiperipheral model. This becomes exact for a factorizable model, but takes into account transverse-momentum effects and explicitly incorporates the deferred thresholds arising from the production of clusters. We do not make the dual-tree approximation for our Reggeon couplings, which we represent instead by a more general exponential form. If we then assume a linear Reggeon trajectory α (t), self-consistency gives an intercept α (0) = 0.49 and a triple-Regge coupling which is in reasonable agreement with experiment. There are no arbitrary parameters in our model.

1677 Lattice approach to string theory. Giles, R.; Thorn, C.B. (Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). **16**: No. 2, 366-386(15 Jul 1977).

We construct a lattice version of dual string theory, which we hope will be useful in systematically analyzing the properties of that theory. Mass renormalization is discussed, and the familiar tachyon problem is seen to arise so long as counterterms are restricted to be local. The dual-loop expansion is discussed and the origin of the critical dimension elucidated. In the interacting theory, the critical dimension is required for Lorentz invariance, but it is also the only dimension for which the coupling-constant renormalization is finite. The choice of bare coupling constant, $g_0 = 1$, is seen to be particularly attractive. If we make this choice, the string interaction coupling constant is calculable in terms of the fundamental rest tension T_0. The instabilities associated with tachyons are discussed, and we propose a method for discovering whether the interactions stabilize the theory. Application of our ideas to the baryon three-string problem is also mentioned.

1678 Trace and dilation anomalies in gauge theories. Collins, J.C.; Duncan, A.; Joglekar, S.D. (Joseph Henry Laboratories, Princeton University, Princeton, New Jersey 08540). **16**: No. 2, 438-449(15 Jul 1977).

The form of the anomaly in the trace of the energy-momentum tensor in a general theory of interacting fermions and non-Abelian gauge bosons is derived. The result is shown to involve precisely those gauge-variant operators which are known to mix with the naive trace under renormalization. The trace is shown to be soft on the mass shell if and only if the theory is at an eigenvalue of the Callan-Symanzik β function. The dilatation anomaly in the matrix element of θ/sup lambda /λ with two electromagnetic currents (to lowest order in electromagnetism, but including all orders of the strong gauge interaction) is derived and shown to be infinitely renormalized in finite orders of strong perturbation theory. This anomaly is then shown to be canonical and given precisely by the lowest-order result provided the strong interactions are summed to all orders before going to the limit of physical space-time dimensions.

STRONG INTERACTIONS, BARYON NO.=0

1679 Asymptotic chiral invariance. II. The Consequences. Mtingwa, S.K. (Department of Physics and Astronomy, University of Rochester, Rochester, New York 14627). **16**: No. 2, 494-502(15 Jul 1977).

Based upon the invariance of SU(2) x SU(2) and SU(3) x SU(3) for asymptotic momenta, we first derive constraints on certain strong and electromagnetic exclusive scattering processes, where all the hadrons are viewed as fundamental fields. Then we consider asymptotic SU x SU(3) for meson-meson and baryon-baryon fixed-angle, elastic scattering in the Landshoff model, wherein the hadrons are viewed as bound states of quarks and antiquarks. We find that that part of the pseudoscalar-pseudoscalar scattering amplitude which is a function of the center-of-mass scattering angle only is just the average of the analogous functions of the scattering angle for the independent nonzero-helicity amplitudes for vector-vector scattering. Finally, in the case of baryon-baryon scattering we find that total baryon helicity is conserved.

STRONG INTERACTIONS, BARYON NO.=1

1680 Unitary coupled-channel analysis of diffractive production of the A_1 resonance. Basdevant, J.L.; Berger, E.L. (Laboratoire de Physique Theorique et Hautes Energies, Universite Pierre et Marie Curie, Paris, France). **16**: No. 3, 657-678(1 Aug 1977).

Employing unitary coupled-channel J/sup P C/ = 1^{++} partial-wave amplitudes for the rhoπ and KK-bar systems, we show that the mass dependence and phase variations of the diffractive data on $\pi p \rightarrow$ (rhoπ) p are indicative of the presence of an A_1 resonance whose mass and width we determine to be roughly 1.3 +- 0.15 GeV and 400 +- 100 MeV, respectively. Our unitary amplitudes incorporate the Deck backgrounds explicitly. The fits to the data are excellent. We point out some interesting quantities to be measured in the future in order to resolve remaining uncertainties.

1681 Baryon spectrum in a linear string model. Cutkosky, R.E.; Hendrick, R.E. (Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213). **16**: No. 3, 786-792(1 Aug 1977).

Results are presented on the spectrum of baryon $SU_6 \times O_3$ supermultiplets based on a relativistic string model with linear string-length potentials. Calculations are carried out for a four-constituent baryon model as well as the normal three-quark model. Deviations from the conventional harmonic-oscillator spectrum, lack of quark-diquark structure, and the possibility of a low-lying $(56,1^-)$ supermultiplet are discussed.

1682 Calculation of the baryon spectrum with a linear Hamiltonian. Cutkosky, R.E.; Hendrick, R.E. (Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213). **16**: No. 3, 793-798(1 Aug 1977).

Baryon $SU_6 \times O_3$ supermultiplet masses are calculated in a model of three relativistic quarks bound by linear plus Coulomb-type potentials. Predictions of the model are in good agreement with known multiplet masses, except for the $(56,1^-)$ state, which is predicted to be 200 MeV too high.

1683 Bound states of charmed baryons and antibaryons. Dover, C.B.; Kahana, S.H.; Trueman, T.L. (Brookhaven National Laboratory, Upton, New York 11973). **16**: No. 3, 799-815(1 Aug 1977).

Within the framework of nonrelativistic potential models, we investigate the possibility that bound states of the type B-bar/sub c/ B/sub c/ may exist, where B/sub c/ is a charmed member of the 20 baryon multiplet of SU(4). By rather general considerations, we establish the approximate level order of the bound-state spectrum. Specific potential models are then invoked to qualitatively estimate the binding energies and rms radii of B-bar/sub c/B/sub c/ bound states. For reasonably small binding energies (< or =1/2 GeV), for which a potential description is sensible, such configurations are found to be "quasimolecular" in nature, i.e., having rms radii considerably larger (> or =0.7 fm) than the corresponding c-barc quark-model states. We show that most of the low-lying states are isospin I = 0 as in the c-barc model. However, because of the coherent effect of tensor forces, certain I = 1 configurations of the C-bar$_1$C$_1$ system experience a downward energy shift, and hence could appear in the same energy region as I = 0 states (e.g., /sup 2I ts[ts1,2S/L/sub J/ = $^{33}P_0$ state near ^{13}P/sub 0,1,2/ states). The states we describe can mix with and modify the properties of c-barc quark states of the same quantum numbers in the J/psi,chi,psi' region from 3.1 to 3.7 GeV. Some of them could appear independently as narrow states in the mass region of 4 GeV. "Exotic" C-bar$_1$C$_1$ states with I = 2 are shown to always lie above I = 0,1 configurations of the same L; however, for a wide class of potential models, the P-wave C-bar$_1$C$_1$ states (^{53}P/sub 0,1,2/,$^{51}P_1$) are still bound close to threshold (~4.8 GeV). We exhibit qualitative arguments that some of these B-bar/sub c/B/sub c/ bound states may be narrow. We discuss possible experimental means for finding the I = 1 and 2 states, i.e., those not predicted by the cc-bar quark model.

1684 Inverse scattering problem with isobars. Londergan, J.T.; Moniz, E.J. (Department of Physics, Indiana University, Bloomington, Indiana 47401). **16**: No. 2, 721-725(Aug 1977).

The inverse scattering problem is solved for a covariant, isobar-dominated scattering amplitude (including inelasticity). Application is made to the πN P_{33} channel, with the πN Δ vertex function and isobar bare mass as results.

1685 Allowance for the unitarity condition in the multiperipheral theory. Roizen, I.I. (P. N. Lebedev Physics Institute, USSR Academy of Sciences). **25**: No. 2, 222-226(Feb 1977).

A fully unitary model of hadronic interactions at high energies is proposed. It is shown that allowance for unitarity in the multiperipheral approach leads to corrections which can be interpreted in terms of Regge theory as a displacement of the original vacuum singularity to the right of the point 1=1.

STRONG INTERACTIONS, BARYON NO. GREATER THAN 1

1686 (COO—3001-186) **Chiral symmetry and the nucleon—nucleon interaction.** Brown, G.E. 1977. Contract EY-76-S-02-3001. 21p. (CONF-770674—2). Dep. NTIS, PC A02/MF A01.

From Nucleon-nucleon interaction meeting; Vancouver, Canada (27 Jun 1977).

The nucleon—nucleon interaction is understood in terms of a dynamic model, the sigma model. The anti NN $\rightarrow \pi\pi$ helicity amplitudes are assumed to be physical data, and the dynamical model must reproduce these data, more or less. 14 references. (JFP)

1687 Duality structure of inclusive diffraction dissociation. Hidaka, K. (High Energy Physics Division, Argonne National Laboratory, Argonne, Illinois 60439). **16**: No. 3, 690-702(1 Aug 1977).

The duality structure of diffraction dissociation is studied in a triple-Regge (TR) analysis of the diffractive process pp $\rightarrow$ pX. A scheme (normal scheme) is proposed which is quite different from the scheme previously suggested by many people (abnormal scheme). Diffractive resonance production is dual to the P/sub t/P/sub t/P_0 (Pomeron exchange) term in the abnormal scheme, whereas it is dual to the P/sub t/P/sub t/R_0 (ordinary Reggeon exchange) term in our normal scheme. From a careful TR analysis performed with much more data, we conclude that the data favor our normal scheme at least for 0.1 < or approx. = t < or $\simeq$ 0.5 (GeV/c)^2. Here t is the mass squared of the external Pomeron (P/sub t/).

1688 Production of hadrons with large transverse momenta in the pionization region. Shoikhet, V.K. (Tbilisi State University). **25**: No. 2, 207-217(Feb 1977).

The covariant parton model of Landshoff and Polkinghorne is used to study the production of hadrons with large transverse momenta (LTM) in the pionization region. Expressions are obtained for the inclusive cross section for the production of a hadron with LTM, the double inclusive cross section for the production of two hadrons with LTM, the two-particle correlator, the differential associated multiplicity, and the average associative multiplicity of hadrons in the "jet" emitted in the direction opposite to that of the hadron with LTM. The possible contributions of Pomeron-exchange diagrams to the inclusive cross sections are analyzed. The theoretical results obtained in this analysis provide a completely satisfactory description of the experimental data.

1689 Multiple production in a peripheral interaction. Theoretical scheme. Ter-Martirosyan, K.A.; Shabel'skii, Y.M. (Institute of Theoretical and Experimental Physics, State Atomic Energy Commission). **25**: No. 2, 217-222(Feb 1977).

When particles are produced in a multiperipheral shower, the multiplicity has a near-Poisson distribution with an average particle number that increases as ln s. However, several multiperipheral showers can be produced simultaneously, on account of the splitting of the colliding nuclei into components during the time of the collision. This article is devoted to an investigation of this effect, first noted by Abramovskii and Kancheli (1973) and leading to an appreciable broadening of the particle multiplicity distribution curves with increasing energy. The results of Abramovskii, Gribov, and Kancheli (AGK, 1973) make it possible to express the probability of simultaneous production of several showers in terms of the contribution of the branch cuts to the elastic-scattering amplitudes, which are presently known with good accuracy from the reduction of the experimental data on the basis of the Regge-scheme formulas. This approach makes it possible (Ter-Martirosyan, 1973; Shabel'skii, 1975; Levin and Ryskin, 1974) to calculate the topological cross sections σ/sub n/(s) =F (n) for the production of n particles in various concrete cases. The cases of NN, NN, and π^{+-}/sup N/(K^{+-}/sup N)/ collisions are considered in detail. The calculations were performed somewhat more accurately than before by Ter-Martirosyan (1973), Shabel'skii (1975), and Levin and Ryskin (1974), with account taken of the contribution of the non-Pomeron singularities. The theory leads to a number of characteristic properties of the distributions with respect to n, which are well confirmed by the experimental data. In particular, at a very high energy, appreciable deviations from KNO scaling should be observed.

PARTICLE INVARIANCE PRINCIPLES AND SYMMETRIES

GENERAL

1690 Symmetry dynamics. Ginzburg, I.F. (Institute of Mathematics, Siberian Division, USSR Academy of Sciences). **25**: No. 2, 227-233(Feb 1977).

The behavior of invariant coupling constants in theories with many fields and coupling constants is considered. At short distances all these coupling constants are small compared to the self-action constant h_0 of one of the fields. If $h_0 \rightarrow$const, the corresponding physical situation is similar to that of the parton picture. At large distances several properties appear: slightly broken isotopic symmetry without exotic states, the σ model, and current algebra; in the case of a sufficiently large number of fields, higher internal symmetries are broken in the spirit of SU (2) reduction of the SU (3) group; here mixing of the type eta-X,... appears.

APPLICATIONS TO ELECTROMAGNETIC AND WEAK INTERACTIONS

1691 Quark and lepton assignments in the E_7 model. Sikivie, P.; Guersey, F. (Physics Department, University of Maryland, College Park, Maryland 20742). **16**: No. 3, 816-834(1 Aug 1977).

The embedding of the SU(2) x U(1) x SU(3)/sup c/ group of weak and electromagnetic interactions and chromodynamics into the gauge group E_7 is discussed in terms of the various possibilities for quark and lepton assignments, including heavy quarks and heavy leptons. It is shown that there is at least one assignment, defined up to a few mixing angles, which agrees with the existing weak-interaction phenomenology. The octonionic structure of the assignment is also exhibited and related to the exceptional observables of Jordan, von Neumann, and Wigner.

APPLICATIONS TO STRONG INTERACTIONS

REFER ALSO TO CITATION(S) 1679

FIELD THEORY

1692 Cancellation of the zero-mode singularities in soliton quantization theory. Matveev, V.A. (Fermi National Accelerator Lab., Batavia, Ill. (USA)). **121**: No. 3, 403-412(11 Apr 1977).

A proof of an exact cancellation of the zero-mode singularities in each order of the loop expansion determining the quantum corrections to soliton (particle-like) solutions of classical field equations is given. The cancellation restores an underlying symmetry broken by a specific classical solution, and is owing to the stability of

the soliton with respect to small perturbations generated by the symmetry group transformations.

1693 Cut Reggeon field theory in the triple-Regge region. Moshe, M.; Paige, F.E. (Department of Physics, University of California, Santa Cruz, California 95064). **16**: No. 3, 869-884(1 Aug 1977).

Reggeon-field-theory rules for the inclusive cross section in the triple-Regge region are given in terms of the cut-Pomeron formalism. A functional-integral representation is constructed and used to obtain the classical approximation, i.e., the sum of all graphs without Pomeron loops. In the limit of zero Pomeron slope, this is shown to give a cross section which vanishes asymptotically so that the inclusive sum rule is not violated. Possible applications to the analysis of experimental data are discussed.

1694 Stability and supersymmetry: general formalism and explicit two-loop applications. Curtright, T.; Ghandour, G. (California Institute of Technology, Pasadena, California, 91125). **106**: No. 2, 209-278(Aug 1977).

A complete account of a perturbative investigation of ground state instability is presented for a massless theory involving scalar, pseudoscalar, and Majorana spinor fields. The effective potential, dimensional regularization, and renormalization group formalisms are briefly reviewed and then applied in detail to show the semiclassical vacuum of the model is unstable due to radiative corrections when the (pseudo)scalar self-interaction strength, f, is less than the fermion- (pseudo)scalar coupling, g^2. Models with stable ground states are found when $f < \text{or} = g^2$, and when $f = g^2$ a supersymmetric theory is obtained. The supersymmetric case is thus encountered as a boundary between stable and unstable models. This result is discussed and is conjectured to be a general feature of supersymmetric theories. All perturbative calculations in the analysis are methodically carried out to the level of two-loop Feynman diagrams, and to this level, a variety of renormalization prescriptions are considered. The correlation of the various ultraviolet divergences for the supersymmetric model is explicitly demonstrated and shown not to hold in the general theory.

1695 Interacting Rarita-Schwinger field on the light front. Singh, L.P.S.; Hagen, C.R. (Physics Department, Pahlavi University, Shiraz, Iran). **16**: No. 2, 347-353(15 Jul 1977).

The coupled spin-3/2 Rarita-Schwinger field is investigated in light-front coordinates. The class of interactions considered includes both minimal and anomalous magnetic-moment couplings to the electromagnetic field, coupling to a scalar field, and coupling to a Dirac and a scalar field. It is shown that the interacting theory suffers from a loss of constraints except when the external field satisfied certain noncovariant conditions. The anticommutators are obtained and are shown not to be positive-definite in the case that no constraints are lost. In the case of fewer constraints they are inconsistent with each other as well as singular in the free-field limit.

1696 Continuous space-time symmetries of the lattice Dirac equation. Chodos, A.; Healy, J.B. (Department of Physics, Yale University, New Haven, Connecticut 06520). **16**: No. 2, 387-396(15 Jul 1977).

We show that the (2 + 1) -dimensional Dirac equation on a square lattice is invariant under a nonlinear representation of the Poincare group. We construct the generators explicitly and show that they reduce in the continuum limit to the usual linear representation of the Poincare algebra. We also discuss the fourfold degeneracy of the lattice Dirac theory, and show how it can be removed by diagonalizing certain discrete transformations that commute with the Poincare generators. The extension of our work to 3 + 1 dimensions and to interacting theories is briefly discussed.

1697 Canonical quantization of fields with higher-derivative couplings. Barua, D.; Gupta, S.N. (Department of Physics, Wayne State University, Detroit, Michigan 48202). **16**: No. 2, 413-416(15 Jul 1977).

It is shown with the use of a model of scalar fields how canonical quantization can be carried out when the free part of the Lagrangian density involves only the first derivatives, while the coupling terms involve higher derivatives. Cancellation of noncovariant terms in the scattering operator is found to occur for such couplings provided that $\delta(0)$ terms are eliminated with the use of dimensional regularization.

1698 Classification of pseudoparticle solutions in gauge theories. Bitar, K.M.; Sorba, P. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). **16**: No. 2, 431-437(15 Jul 1977).

We discuss the classification of pseudoparticle solutions obtained using all inequivalent embeddings of SU(2) in a semisimple algebra G. We also discuss some simple consequences of this classification on the interaction of the pseudoparticles of Belavin et al.

1699 Linearly rising soliton trajectories. Chu, S.; Kaus, P. (Department of Physics, University of California, Riverside, California 92502). **16**: No. 2, 503-510(15 Jul 1977).

Linearly rising soliton trajectories without parity partners are obtained from the nonlinear field euqations of a Direc field in four dimensions with universal Fermi self-interaction. The model is Lorentz and global-gauge invariant.

1700 Necessary and sufficient conditions for the existence of a lagrangian in field theory. III. Generalized analytic representations of tensorial field equations. Santilli, R.M. (Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). **105**: No. 2, 227-258(Jun 1977).

In this paper we first study the equivalence transformations of class C^2, regular, tensorial, quasi-linear systems of field which (a) preserve the continuity, regularity, and quasi-linear structure of the systems; and (b) occur within a fixed system of Minkowski coordinates and field components. We identify, among the transformations of this class, those which either induce or preserve a self-adjoint structure of the field equations and we term them genotopic and isotopic transformations, respectively. We then give the necessary and sufficient conditions for an equivalence transformation of the above type to be either genotopic or isotopic. By using this methodology, we then extend the theorem on the necessary and sufficient condition for the existence of ordered direct analytic representations introduced in the preceding paper to the case of ordered indirect analytic representations in terms of the conventional Lagrange equations; we introduce a method for the construction of a Lagrangian, when it exists, in this broader context; and we explore some implications of the underlying methodology for the problem of the structure of the Lagrangian capable of representing interactions within the framework of the indirect analytic representations. Some of the several aspects which demand an inspection prior to the use of this analytic approach in actual models are pointed out.In particular, we indicate a possible deep impact in the symmetries and conservation laws of the system generated by the use of the concept of indirect analytic representation.

1701 Production of particles with large p/sub perpendicular/in quantum electrodynamics with a photon having a mass. Efremov, A.V.; Rai-Choudhury, P. (Joint Institute for Nuclear Research). **25**: No. 2, 201-203(Feb 1977).

The processes pp→pX with large transverse momentum P/sub perpendicular/and pp→$\mu^+\mu^-$X with large mass Q/sub mumu/ are considered in the lower orders of quantum electrodynamics with a photon having a mass. It turns out that the behavior of these processes is the same as in the theory with scalar gluons, i.e., $Ed^3\sigma/d^3p \sim 1/p^4$/sub perpendicular/and $d\sigma/dQ^2 \sim 1/Q^4$.

1702 Scale-invariant solutions of renormalizable field theories. Ushveridze, A.G. (Physical Institute of the Academy of Sciences of the Georgian SSR, Tbilisi). **25**: No. 2, 234-237(Feb 1977).

A solution is sought for the generalized unitarity conditions in scalar phi^3 and phi^4 theories. It is shown that the system may admit a scaling solution in spaces of high dimensionality.

1703 K/sub L/-K/sub S/ mass difference in an asymptotically free gauge theory. Malakyan, Y.P. (Physics Research Institute of the Academy of Sciences of the Armenian SSR, Erevan). **25**: No. 2, 238-240(Feb 1977).

In the framework of the Weinberg-Salam model and the standard four-quark picture we have calculated the mass difference between the K/sub L/- and K/sub S/- mesons. The influence of the strong interactions at short distances has been taken into account in the framework of an asymptotically free gauge theory, and it is shown that the total effect is small. For the mass of the charmed quark we have obtained the interval $1.7 < \text{or} = m/\text{sub } c/ < \text{or} = 2.9$ GeV, owing to the indeterminacy in the contribution from large distances.

SCATTERING THEORY

1704 Solution of Kadyshevskii's equation by Bateman's method. Belyaev, V.B.; Irgaziev, B.F. (Joint Institute for Nuclear Research). **25**: No. 2, 242-245(Feb 1977).

The Bateman method, previously developed for the solution of the Lippmann-Schwinger equation, is used to obtain the solution of the relativistic two-body problem in the Kadyshevskii formulation. A solution of the scattering and the bound-state problems is given for relativized versions of two phenomenological potentials.

PHYSICS RESEARCH (CONT.)

NUCLEAR PROPERTIES AND REACTIONS, A=1-5, THEORETICAL

RADIOACTIVE DECAY

1705 Simple formula for the vertex form factor of the virtual decay of a three-particle nucleus. Belyaev, V.B.; Irgaziev, B.F.; Orlov, Y.V. (Institute of Nuclear Physics of the Moscow State University). **25**: No. 2, 150-152(Feb 1977).

In the solution of the Faddeev equations in practice the pair t matrix is usually approximated by a finite number of separable terms, which enables one to reduce the problem to the solution of a system of one-dimensional integral equations. In so doing, the Faddeev component psi/sup i k/ of the "nonmassive" wave function of the three-particle system depends explicitly on the pair energy E/sub i k/. It is shown that in this case by a simple limiting transition in the energy E/sub i k/ to the pole corresponding to a bound (quasi-bound) state of the two-particle subsystem {ik}, it is possible to find the vertex function of the virtual decay {ikl}→{ik}+l with particle l on the mass shell directly from the wave function psi/sup i k/ without calculating the overlap integral. As an example we consider the application of the Bateman method to the virtual decay of tritium into a deuteron (a "singlet deuteron") and a real neutron.

1706 Three-nucleon calculations based on the interpolation approach. Baz', A.I.; Skhirtladze, V.S.; Shitikova, K.V. (I. V. Kurchatov Institute of Atomic Energy). **25**: No. 2, 153-156(Feb 1977).

The basic characteristics of the ^{3}H nucleus, namely the binding energy, mean square radius and virtual $^3H \rightarrow n+D$ decay coupling constant, are calculated for two different central potentials, using the interpolation approach to nuclear theory and accounting for the binary nD-decay channel explicitly. The effect of the "cluster" function in these calculations is studied, as is the role of the "internal" wave function describing the pure three-nucleon bound state, in calculations of the doublet phase shift in elastic nD scattering.

NUCLEAR REACTIONS AND SCATTERING

1707 Role of the triplet state in radiative capture of thermal neutrons by protons. Kolomenskii, E.A.; Kopeliovich, V.B.; Lobashev, V.M.; Nazarenko, V.A.; Okorokov, A.I.; Pirozhkov, A.N.; Smotritskii, L.M.; Kharkevich, G.I.; Shchebetov, A.F. (Leningrad Institute of Nuclear Physics, USSR Academy of Sciences). **25**: No. 2, 127-130(Feb 1977).

A method is proposed for determination of the contribution of the $^3S_1$ state in radiative np capture by measurement of the circular polarization of the γ rays on capture of a polarized neutron by a proton. Experiments carried out with this method are described. It is shown that the circular polarization is P/sub γ/which limits the possible contribution of the triplet state to the cross section of the reaction under study to a level of σ/sub t/9 or $\approx 2 \times 10^{-4} \sigma$/sub s/.

1708 Dispersion approach to the electrodisintegration of the deuteron and the wave function of the np system. Kirillov, A.I.; Troitskii, V.E. (Moscow Energy Institute). **25**: No. 2, 157-160(Feb 1977).

The equivalence of the dispersion approach and the Schroedinger approach to a description of the final-state n-p interaction in electrodisintegration of the deuteron is established. In this connection it is shown that the contribution from unphysical cuts to the electrodisintegration amplitude and to the wave function of the np system can be uniquely reconstructed from the np-scattering phase shifts.

1709 Elastic scattering of K^+ mesons by deuterons at low energies. Blokhintsev, L.D.; Safronov, A.N. (Institute of Nuclear Physics of Moscow State University). **25**: No. 2, 171-176(Feb 1977).

Elastic K^+d scattering at low energies is considered in the framework of a diagram formalism. Taking account of all the diagrams of first and second orders in the K^+N interaction, the K^+d scattering amplitude is constructed in different versions of the theory including the K-matrix approach and the Pade approximation. The NN amplitude describing the rescattering of nucleons in the intermediate state is selected in a separable form, and the K^+N amplitude is taken in the approximation of a zero-range interaction. The mass difference between K^0 and K^+ mesons and the Coulomb interaction are taken into consideration in the calculation of the differential cross section. The results obtained in the different versions of the theory are compared with each other and also with the results of other calculations. In particular it is shown that the NN interaction in the intermediate state plays an essential role.

NUCLEAR PROPERTIES AND REACTIONS, A=1-5, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 1707

1710 ^{3}H(α,^{6}Li) n reaction at 0°. Brown, R.E.; Ohlsen, G.G.; Haglund, R.F. Jr.; Jarmie, N. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). **16**: No. 2, 513-525(Aug 1977).

We have measured excitation functions for the reaction ^{3}H(α,^{6}Li) n at 0° (lab) in an energy range covering the resonance corresponding to the $5/2^-$ state in ^{7}Li at 7.46 MeV of excitation. A Ti-tritide target on a nickel backing was bombarded by an α-particle beam, and the ^{6}Li reaction products at 0° were spatially separated from the beam in a magnetic field and were then detected in a thin solid-state detector. Data at 14 bombarding energies were obtained for the ^{6}Li group emitted at θ/sub c.m./ = 0°, and data at 11 energies were obtained for the ^{6}Li group emitted at θ/sub c.m./ = 180°. To normalize these reaction data we measured, simultaneously with the reaction, the yield of the elastically recoiling tritons at +- 15° and +- 30° (lab). We obtained absolute differential cross sections from the normalized reaction data by measuring excitation functions for ^{3}H(α,t)^{4}He at 15° and 30° (lab) using a gas target. The average error in the reaction data is 2.7%; the errors in the 15° elastic data are less than 1%; the majority of the errors in the 30° elastic data are less than 2%; and the α-particle beam energy at the reaction region of the targets was determined to an accuracy of 6 keV. Our reaction data are compared with other data, data evaluations, and a recent three-channel multilevel R-matrix analysis of a large body of mass-7 data.

1711 Effects of the deuteron D state in sub-Coulomb (d, p) reactions. Knutson, L.D. (University of Wisconsin, Madison, Wisconsin 53706). **106**: No. 1, 1-25(Jul 1977).

Angular distributions of the cross section, the vector analyzing power, and the three tensor analyzing powers have been measured for (d, p) reactions on ^{90}Zr at 5.5 MeV and ^{208}Pb at 9.0 MeV. The measurements are compared with calculations based on the distorted-wave Born approximation. For ^{208}Pb the calculations are in excellent agreement with the measurements, while for ^{90}Zr the agreement is only qualitative. The effect of the deuteron D state on the measured quantities is investigated. It is shown that the tensor analyzing powers arise almost entirely from the D state. A semiclassical model for sub-Coulomb (d, p) reactions is presented. This model successfully reproduces the qualitative features of the observed analyzing powers, and makes it possible to understand why the D state has a large effect on the tensor analyzing powers.

1712 π^-p→$\pi^0\pi^0$n and π^-p→$\pi^0\gamma$n at 270 MeV. Bunyatov, S.A.; Zholobov, G.V.; Zalikhanov, B.Z.; Kurbatov, V.S.; Musakhanov, M.M.; Khalbaev, A.; Yarba, V.A. (Joint Institute for Nuclear Research). **25**: No. 2, 177-181(Feb 1977).

Partial cross sections $d^4\sigma/d\Omega_1 d\Omega_2 dE$/sub γ/dE/sub γ/ for γ production in the reactions π^-p→$\pi^0\pi^0$n and π^-p→$\pi^0\gamma$n are measured with a 4-channel hodoscope of Cerenkov γ spectrometers and with scintillation counters. The γ spectra for both reactions are obtained at laboratory angles 60°, 90°, and 120°. The cross section for π^-p→$\pi^0\gamma$n is calculated. The total cross section for π^-p→$\pi^0\pi^0$n is 0.32 +- 0.04 mb; the total cross section for π^-p→$\pi^0\gamma$n at E/sub γ/ MeV is 0.33 +- 0.03 mb. An isotopic analysis of the $\pi N \rightarrow \pi\pi N$ reactions is carried out at 270 MeV. It is shown that in the soft-pion model the total cross sections for $\pi N \rightarrow \pi\pi N$ cannot be described by any of the considered variants of chiral symmetry breaking.

1713 Experimental determination of the Coulomb energy of the ^{6}Li nucleus. Buki, A.Y.; Shevchenko, N.G.; Efros, V.D.; Chkalov, I.I. (Khar'kov Physico-technical Institute, Ukrainian Academy of Sciences). **25**: No. 2, 246-247(Feb 1977).

The nuclear form factor for ^{6}Li was determined by measuring the spectra of scattered electrons over the energy range 82—292 MeV. The results agree with the predictions of the cluster model.(AIP)

NUCLEAR PROPERTIES AND REACTIONS, A=6-19 THEORETICAL

MASS, ABUNDANCE, AND BINDING ENERGY

1714 Effective interactions: Qualitative discussion of Hartree-Fock effects. Goodin, F.L.; Ellis, P.J.; Goode, P.R. (School of Physics and Astronomy, University of Minnesota, Minneapolis, Minnesota 55455). **16**: No. 2, 784-791(Aug 1977).

We calculate the effective interaction for ^{18}O in a simulated Hartree-Fock basis by taking a fixed oscillator parameter of 1.7 fm

for the s and p shells and a variable parameter b/sub u/ for the sd and pf shells. A central interaction is used and diagrams of first, second, and third order in V are calculated. The dominant effect is one of scaling with diagrams of second and third order all decreasing in the same exponential fashion as a function of b/sub u/. Comparing pure oscillator (b/sub u/ = 1.7 fm) and simulated Hartree-Fock (b/sub u/ = 2.0 fm) results, we find a reduction factor of roughly 0.7, 0.7^2, and 0.7^3 for first, second, and third order, respectively. Diagrams containing a particle-particle ladder usually fall off somewhat less rapidly than the others. The implications of these model results are discussed.

NUCLEAR PROPERTIES AND REACTIONS, A=6-19, EXPERIMENTAL

RADIOACTIVE DECAY

1715 Half-life of ^{17}F. Alburger, D.E. (Brookhaven National Laboratory, Upton New York 11973). **16**: No. 2, 889-890(Aug 1977).

^{17}F was made in the ^{16}O(d,n)^{17}F reaction, using a target of Ta_2O_5 enriched in ^{16}O, and its half-life was measured by detecting β rays in a plastic scintillator. A value of 64.80 +- 0.12 sec was obtained in agreement with an earlier but less accurate measurement.

NUCLEAR REACTIONS AND SCATTERING

1716 Comparison of light- and heavy-ion emission from the ^{12}C + ^{16}O system. Tabor, S.L.; Eisen, Y.; Kovar, D.G.; Vager, Z. (Argonne National Laboratory, Argonne, Illinois 60439). **16**: No. 2, 673-678(Aug 1977).

Excitation functions of the total proton and α-particle yields from the ^{12}C+^{16}O reaction have been measured in the range E/sub c.m./=12.9 to 27.4 MeV, with angular distribution measurements at E/sub c.m./=14.9, 21, and 26.6 MeV. For comparison, the elemental distribution of evaporation residues was also measured at the latter three energies. The α excitation curve exhibits structure corresponding to the oscillations seen in an earlier measurement of the total fusion cross section, while the proton cross section increases rather smoothly with energy. At 15 MeV all the proton and α cross section is accounted for by the observed evaporation residues, but an increasing excess of light-ion production is seen at the higher energies. The excess cross section, if interpreted as 3α production, compensates for the previously observed decrease in fusion cross section below the expected total reaction cross section.

1717 Reaction cross sections for ^{16}O + ^{16}O. Kolata, J.J.; Fuller, R.C.; Freeman, R.M.; Haas, F.; Heusch, B.; Gallmann, A. (Brookhaven National Laboratory, Upton, New York 11973). **16**: No. 2, 891-894(Aug 1977).

The total fusion cross section σ/sub f/ for ^{16}O + ^{16}O has been measured in 500 keV steps between 12.5 and 30.5 MeV c.m. energy via γ-ray techniques. The excitation function for σ/sub f/ shows clear evidence of periodic structure between 14 and 28 MeV (c.m.), as predicted by the optical model. These oscillations are out of phase with those observed in 90° elastic scattering. Individual yields of 12 nuclides formed in the reaction were also obtained. The narrow (Γ < or = 1 MeV) resonance at E/sub c.m./ = 26.5 MeV, which is correlated in the ^{20}Ne and ^{16}O (3^-) channels, is suggested to be an "α-exchange" resonance.

NUCLEAR PROPERTIES AND REACTIONS, A=20-38, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

1718 Central collisions of relativistic heavy ions. Gosset, J.; Gutbrod, H.H.; Meyer, W.G.; Poskanzer, A.M.; Sandoval, A.; Stock, R.; Westfall, G.D. (Lawrence Berkeley Laboratory, Berkeley, California 94720). **16**: No. 2, 629-657(Aug 1977).

The energy spectra of protons and light nuclei produced by the interaction of ^{4}He and ^{20}Ne projectiles with Al and U targets have been investigated at incident energies ranging from 0.25 to 2.1 GeV per nucleon. Single fragment inclusive spectra have been obtained at angles between 25° and 150°, in the energy range from 30 to 150 MeV/nucleon. The multiplicity of intermediate and high energy charged particles was determined in coincidence with the measured fragments. In a separate study, fragment spectra were obtained in the evaporation energy range from ^{12}C and ^{20}Ne bombardment of uranium. We observe structureless, exponentially decaying spectra throughout the range of studied fragment masses. There is evidence for two major classes of fragments; one with emission at intermediate temperature from a system moving slowly in the lab frame, and the other with high temperature emission from a system propagating at a velocity intermediate between target and projectile. The high energy proton spectra are fairly well reproduced by a nuclear fireball model based on simple geometrical, kinematical, and statistical assumptions. Light cluster emission is also discussed in the framework of statistical models.

1719 Energetic charged particle yields induced by pions on complex nuclei. Jackson, H.E.; Kaufman, S.B.; Meyer-Schuetzmeister, L.; Schiffer, J.P.; Tabor, S.L.; Vigdor, S.E.; Worthington, J.N.; Rutledge, L.L. Jr.; Segel, R.E.; Burman, R.L.; Gram, P.A.M.; Redwine, R.P.; Yates, M.A. (Argonne National Laboratory, Argonne, Illinois 60439). **16**: No. 2, 730-740(Aug 1977).

The spectra of protons (60 < E/sub p/ <200 MeV) and deuterons (80 MeV < E/sub d/) produced by 100- and 220-MeV π^+ and π^- on Al, Ni, and Ta targets were measured. The shapes of proton spectra are similar for π^+ and π^-, with absolute yields in ~3 : 1 ratio; the yields vary as ~A/sup 2/3/. The exception is the forward-angle yield at 100 MeV where the proton spectra with π^+ are different in shape from π^-, the yield ~5 times as high, and the target dependence is ~A/sup 1/3/. This pattern is not readily understood at the present time.

NUCLEAR PROPERTIES AND REACTIONS, A=39-58, THEORETICAL

NUCLEAR REACTIONS AND SCATTERING

1720 Core polarization in inelastic scattering. Petrovich, F.; McManus, H.; Borysowicz, J.; Hammerstein, G.R. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). **16**: No. 2, 839-872(Aug 1977).

Inelastic scattering is a source of much useful information about core polarization effects in nuclei near closed shells. Although there have been many theoretical treatments of core polarization effects reported in the literature, the results of these calculations have rarely been applied to the interpretation of inelastic scattering data. In the present paper we review the microscopic models for the treatment of inealstic proton and electron scattering and the microscopic models for the treatment of core polarization. Estimates are made of core excited admixtures in the wave functions for low-lying states in ^{42}Ca, ^{50}Ti, ^{89}Y, ^{90}Zr, ^{207}Pb, and ^{209}Bi. The resulting wave functions are used to calculate theoretical (p,p') cross sections and (e,e') form factors for comparison with available experimental data. "Realistic" G matrix interactions are used as the starting point in both the structure and the (p,p') calculations. In the structure calculations the interaction is modified by means of a "bootstrap" prescription to account for important long-range core correlations and in the (p,p') calculations it is modified by the addition of an imaginary component. It is concluded that the overall features of the experimental data can be understood from these calculations.

NUCLEAR PROPERTIES AND REACTIONS, A=39-58, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

1721 Back-angle anomalies in ^{6}Li scattering from ^{40}Ca and ^{44}Ca. Bohn, H.; Eberhard, K.A.; Vandenbosch, R.; Bernhardt, K.G.; Bangert, R.; Chan, Y. (Nuclear Physics Laboratory, University of Washington, Seattle, Washington 98195). **16**: No. 2, 665-672(Aug 1977).

Angular distributions for the elastic and inelastic scattering of 30 MeV ^{6}Li ions from ^{40}Ca and ^{44}Ca have been measured. At backward angles (110°—180°) the cross sections for both elastic and inelastic scattering are an order of magnitude larger for ^{6}Li + ^{40}Ca than for ^{6}Li + ^{44}Ca. The results are compared with the anomalies observed in α and ^{3}He scattering. The difference between the back-angle scattering for ^{40}Ca and ^{44}Ca is discussed in terms of the relative number of competing direct reaction channels capable of carrying away large amounts of angular momentum.

NUCLEAR PROPERTIES AND REACTIONS, A=90-149, EXPERIMENTAL

REFER ALSO TO CITATION(S) 1720

NUCLEAR REACTIONS AND SCATTERING

1722 Resonance scattering of annihilation γ rays by ^{106}Pd nuclei. Gavrilov, M.G.; Davydov, A.B.; Korotkov, M.M. (Institute of Theoretical and Experimental Physics, State Commission on Use of Atomic Energy). **25**: No. 2, 131-135(Feb 1977).

Measurements are described of the cross section for resonance scattering by ^{106}Pd nuclei of annihilation γ rays arising in annihilation of positrons in polycrystalline metallic copper. The absolute

differential cross section for a scattering angle of 110° has been determined by comparison of resonance and Rayleigh scattering with use of the known data on differential cross sections for the latter. The total cross section for resonance scattering is calculated on the assumption that the angular distribution of the scattered γ rays, as a consequence of the short lifetime of the nucleus in the excited state, does not undergo a major perturbation. This cross section is (0.72 +- 0.23) x 10^{-27} cm^2, which with allowance for the shape of the annihilation-radiation spectrum of copper leads to a mean life of the ^{106}Pd nucleus in the excited state with energy 511.76 +- 0.08 keV of (1.97 +- 0.64) x 10^{-11} sec.

1723 Many-nucleon-transfer reactions in the system ^{94}Zr+^{22}Ne. Mikheev, V.L.; Artyukh, A.G.; Volkov, V.V.; Gridnev, G.F. (Joint Institute for Nuclear Research). **25**: No. 2, 139-143(Feb 1977).

In bombardment of ^{94}Zr by ^{22}Ne ions with energy 174 MeV we have measured the energy spectra and production cross sections of the isotopes Be, B, C, N, and O at an angle of 12° in the lab. For the Be, B, C, and N isotopes we have established an exponential dependence of dσ/dΩ on the mass difference of the initial and final nuclei. We discuss the possibility of explaining the observed features of the cross-section systematics in terms of the hypothesis of partial statistical equilibrium in the system of interacting nuclei.

NUCLEAR PROPERTIES AND REACTIONS, A=150-189, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

1724 Coexistence of three nuclear shapes in ^{151}Eu. Struble, G.L.; Oelrich, I.C.; Carlson, J.B.; Mann, L.G.; Lanier, R.G. (University of California, Lawrence Livermore Laboratory, Nuclear Chemistry Division, Livermore, California 94550). **39**: No. 9, 533-536(29 Aug 1977).

Levels in ^{151}Eu were populated using the (d, t) reaction. Most of the cross section is concentrated between an excitation energy of 2.2 and 2.6 MeV while levels below 261 keV were not observed. We interpret this as evidence for the coexistence of three district shapes in ^{151}Eu.

1725 Gamma-ray spectra from capture of 2-eV to 3-keV neutrons by ^{181}Ta. Stelts, M.L.; Browne, J.C. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). **16**: No. 2, 574-587(Aug 1977).

The spectra of γ rays from the capture of neutrons by ^{181}Ta were measured at the Livermore 100-MeV linac for neutrons from 2 eV to 3 keV with a Ge(Li) -NaI three-crystal spectrometer. Neutron resonances were resolved to 200-eV neutron energy. Individual primary γ-ray transitions to final states in ^{182}Ta were resolved to 1778-keV excitation energy. These transitions were used to place 110 states with spin and parity assignments in the ^{182}Ta level diagram. A set of 1240 E1 transition strengths was extracted from 19 neutron resonances of known spin and parity. The most likely chi² fit to the distribution of these widths yielded 1.38 +- 0.11 degrees of freedom. The E1 transition strengths were also examined for correlations with the reduced neutron widths of the initial and final states. The E1 strength function was extracted for E/sub γ/to 6.1 MeV and compared with previous results.

1726 Unique first forbidden beta decay of ^{183}Re and ^{185}Os. Brenner, D.S.; Lindner, M.; Meyer, R.A. (Jeppson Laboratory, Clark University, Worcester, Massachusetts 01610). **16**: No. 2, 747-752(Aug 1977).

The decays of ^{183}Re and ^{185}Os were studied by γ-ray spectroscopy using Ge(Li) detectors. The logf$_1$t value for the 5/2 5/2⁺[402] → 9/2 1/2⁻[510] transition between ^{183}Re and ^{183}W was 9.3, which contrasts to the previously reported value of 8.0. The 5/2 1/2⁺[402] K-2 γ-vibrational state of ^{185}Re was identified for the first time at 768.93 keV. This level is populated from the 1/2 1/2⁻[510] ground state of ^{185}Os with a logf$_1$t value of 10.4.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 1719

NUCLEAR PROPERTIES AND REACTIONS, A=190-219, THEORETICAL

NUCLEAR REACTIONS AND SCATTERING

1727 Combined eikonal description of the scattering of fast protons and electrons and the nuclear densities. Starodubskii, V.E.; Shaginyan, V.R.; Sholokhov, Y.I. (Leningrad Institute of Nuclear Physics, USSR Academy of Sciences). **25**: No. 2, 167-171(Feb 1977).

An eikonal method is developed for a combined description of the elastic and inelastic scattering of electrons and high-energy protons. Taking the ^{208}Pb nucleus as an example, the proton and neutron densities for the ground state and the transition densities for the 3⁻ level (2.6 MeV) are determined.

NUCLEAR PROPERTIES AND REACTIONS, A=190-219, EXPERIMENTAL

RADIOACTIVE DECAY

1728 Nuclear data sheets for A=214. Toth, K.S. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). **21**: No. 4, 437-466(Aug 1977).

Nuclear structure information for all nuclei with mass number A=214 is evaluated. The results from various decay experiments and reaction studies are compared. Adopted data, levels, and spin and parity assignments are given.

1729 Nuclear data sheets for A=218. Toth, K.S. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). **21**: No. 4, 467-478(Aug 1977).

Nuclear structure information for all nuclei with mass number A=218 is evaluated. The results from various decay experiments are compared. Adopted data, levels, and spin and parity assignments are given.

ENERGY LEVELS AND TRANSITIONS

1730 Fine structure of the magnetic dipole giant resonance in ^{208}Pb. Raman, S.; Mizumoto, M.; Macklin, R.L. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). **39**: No. 10, 598-601(5 Sep 1977).

Eighteen M1 transitions to the ^{208}Pb ground state have been identified and their radiative widths measured in a study of the reaction ^{207}Pb(n, γ) combined with the results from recent neutron transmission and elastic scattering measurements. In the excitation region between 7.37 and 8.23 MeV, ~ 50% of the expected total M1 strength in ^{208}Pb has been located.

1731 Coulomb excitation of 2⁺ and 3⁻ states in ^{192}Pt and ^{194}Pt. Ronningen, R.M.; Piercey, R.B.; Ramayya, A.V.; Hamilton, J.H.; Raman, S.; Stelson, P.H.; Dagenhart, W.K. (Physics Department, Vanderbilt University, Nashville, Tennessee 37235). **16**: No. 2, 571-573(Aug 1977).

Coulomb excitation of ^{192} ^{194}Pt, by 14.9 MeV α particles was studied by the magnetic analysis of the particles scattered into 150°. For ^{192}Pt, B (E2;0⁺ → 2⁺) values to the 2⁺ states at 317 and 612 keV are 1.89 +- 0.03 $e^2 b^2$ and 0.013 +- 0.002 $e^2 b^2$, respectively. For ^{194}Pt, the B (E2) up-arrow values to the 2⁺ states at 329 and 633 keV are 1.68 +- 0.03 $e^2 b^2$ and 0.0094 +- 0.0015 $e^2 b^2$, respectively. States with J/sup π/- at 1378 keV in ^{192}Pt and 1432 in ^{194}Pt are also excited, with B (E3) up-arrow values of 0.17 +- 0.03 $e^2 b^3$ and 0.14 +- 0.03 $e^2 b^3$, respectively. We compare our measurements to others.

1732 High spin states in ^{206} ^{204} ^{202}Tl observed in (d,α) reactions at 80 MeV. Frascaria, N.; Didelez, J.P.; Chant, N.S.; Chang, C.C. (Institut de Physique Nucleaire, BP 1, 91406 Orsay, France). **16**: No. 2, 603-612(Aug 1977).

The (d,α) reaction on ^{208} ^{206} ^{204}Pb has been studied at 80 MeV bombarding energy. The experimental angular distributions are structured and the transferred angular momentum L could be determined without ambiguity from a comparison of distorted-wave Born-approximation calculations with the experimental angular distributions. The angular momentum matching conditions greatly favored large values of L and allowed the identification of J/sup π/- and 9⁺ states in ^{208} ^{204} ^{202}Tl. Data for the ^{208}Pb(d,α)^{206}Tl reaction were compared with shell model calculations. The properties of nine levels could be correlated with very good agreement with those of states predicted in the shell model calculations. Both zero-range and exact finite-range distorted-wave Born approximation calculations were carried out. Unlike the zero-range distorted-wave Born-approximation results, the exact finite-range angular distributions did not change greatly for different choices of the α particle optical potential. Although somewhat better agreement with the relative cross sections was obtained, the exact finite-range calculations underestimated the absolute cross sections by roughly a factor of 50.

NUCLEAR REACTIONS AND SCATTERING

1733 Quadrupole transfer strength studied through heavy-ion induced two-neutron transfer between the shape transitional nuclei ^{190} ^{192}Os. Hanson, D.L.; Erb, K.A.; Vaagen, J.S.; Ascuitto, R.J.; Bromley, D.A.; Kolata, J.J. (Wright Nuclear Structure Laboratory, Yale University, New Haven, Connecticut 06520). **16**: No. 2, 902-905(Aug 1977).

A coupled-channels Born-approximation analysis of the reaction $^{192}Os(^{12}C,^{14}C)^{190}Os$ at E/sub lab/ = 70 MeV demonstrates that the direct quadrupole transfer strength is very weak, in continuation of the trend found previously in a study of the tungsten nuclei. Elastic and inelastic scattering data for the ^{12}C channel were also taken and analyzed in a conventional coupled-channels model to determine the relative motion.

1734 Formation of neutron-deficient isotopes of francium and radon in bombardment of iridium by neon ions. Kabachenko, A.P.; Kuznetsov, I.V.; Soo, L.G.; Tarantin, N.I. (Joint Institute for Nuclear Research). **25**: No. 2, 135-139(Feb 1977).

The electromagnetic mass separator EMSONHIB has been used to determine the yields of neutron-deficient isotopes of francium and radon in bombardment of a thick iridium target by ^{20}Ne ions accelerated to 200 MeV. The experimental results are compared with calculations according to the statistical model of evaporation of neutrons and protons from the excited compound nucleus. Data are obtained on the temperature and the effective height of the Coulomb barrier, which determines the probability of proton emission on deexcitation.

NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, EXPERIMENTAL

RADIOACTIVE DECAY

1735 Nuclear data sheets for A=222. Toth, K.S. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). **21**: No. 4, 479-492(Aug 1977).

Nuclear structure information for all nuclei with mass number A=222 is evaluated. The results from various decay experiments are compared. Adopted data, levels, and spin and parity assignments are given.

1736 Nuclear data sheets for A=234. Ellis, Y.A. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). **21**: No. 4, 493-548(Aug 1977).

The available nuclear structure information for all nuclei with mass number A=234 is presented. Various decay and reaction data are evaluated and compared. Inconsistencies and discrepancies are indicated. Adopted data, levels, spin, parity and configuration assignments are given.

1737 Nuclear data sheets for A=238. Ellis, Y.A. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). **21**: No. 4, 549-613(Aug 1977).

The available nuclear structure information for all nuclei with mass number A=238 is presented. Various decay and reaction data are evaluated and compared. Adopted data, levels, spin, parity and configuration assignments are given.

1738 Nuclear data sheets for A=242. Ellis, Y.A.; Haese, R.L. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). **21**: No. 4, 615-642(Aug 1977).

The available nuclear structure information for all nuclei with mass number A=242 is presented. Various decay and reaction data are evaluated. Adopted data, levels, spin and parity assignments are given.

ENERGY LEVELS AND TRANSITIONS

1739 Low-spin states in ^{235}U studied with the (n,γ) reaction. Koene, B.K.S.; Chrien, R.E. (Brookhaven National Laboratory, Upton, New York 11973). **16**: No. 2, 588-596(Aug 1977).

Primary γ rays following neutron capture in ^{234}U at the 5.19, 31.2, and 48.8 eV resonances have been studied with a fast chopper. Levels in ^{235}U were identified to an excitation energy of 2.2 MeV. For most of the primary transitions it was possible to distinguish between E1 and M1 multipolarity on the basis of their absolute widths at the different neutron energies. Data from previous thermal-capture work were included in this analysis. The resulting spin-parity restrictions for levels of ^{235}U are compared with earlier rotational-band assignments from charged-particle reactions and thermal neutron capture.

NUCLEAR REACTIONS AND SCATTERING

1740 Reactions of ^{237}Np with ^{4}He near the interaction barrier. Lin, S.Y.; Alexander, J.M. (Department of Chemistry, State University of New York at Stony Brook, Stony Brook, New York 11794). **16**: No. 2, 688-693(Aug 1977).

Cross sections have been measured for the reactions $^{237}Np(^{4}He,f)$, $(^{4}He,n)$, $(^{4}He,2n)$ at energies below the interaction barrier (17.5—22.5 MeV). The total reaction cross sections have been fitted to an equation for theoretical barrier penetration and parameters describing the interaction barrier have been obtained.

1741 Fission and neutron emission in the actinides at excitation energies of 10—35 MeV. Gilat, J.; Fleury, A.; Delagrange, H.; Alexander, J.M. (Chemistry Department, Brookhaven National Laboratory, Upton, New York 11973). **16**: No. 2, 694-705(Aug 1977).

The statistical model description of fission through a double humped barrier has been extended from 12 to ≳35 MeV. Calculations have been compared with measured cross sections for $^{237}Np(^{4}He,xn)$ reactions giving evaporation residues and fission isomers. A generally good fit to the data has been obtained with level densities from theory and fission barriers that give good fits to the direct reaction fission probabilities at low energies (< or = 12 MeV). In detail there are some significant differences between calculation and experiment. We have explored the sensitivity to the various parameters but have not suggested major redefinitions of level densities, second barriers, and/or isomer masses. The effect of preequilibrium mechanisms has been estimated via the hybrid model of Blann et al. These effects are small for energies at or below the excitation function peaks, but they dominate at high energies. The hybrid model seems to predict too many very high energy neutrons.

SPONTANEOUS AND INDUCED FISSION

1742 Energy spectra of electrons and antineutrinos from fragments in thermal-neutron fission of ^{235}U and ^{239}Pu. Borovoi, A.A.; Dobrynin, Y.L.; Kopeikin, V.I. (I. V. Kurchatov Atomic Energy Institute). **25**: No. 2, 144-147(Feb 1977).

The choice between the different variants of weak-interaction theory requires increased accuracy of neutrino experiments. For reactor experiments this requirement necessarily involves a good knowledge of the energy spectrum of nu-bar/sub e/ from ^{235}U fission fragments. In addition, in most apparatus used for this purpose a significant amount of ^{239}Pu accumulates, and therefore the spectrum of nu-bar/sub e/ can be distorted with passage of time. We present calculations of the stationary energy spectra of antineutrinos and electrons emitted by fission fragments from thermal-neutron fission of ^{235}U and ^{239}Pu. It is shown that the spectra of leptons from ^{239}Pu fission products are significantly softer than the analogous spectra from ^{235}U. Calculations of the cross sections for processes averaged over the nu-bar/sub e/ spectra for ^{235}U and ^{239}Pu indicate the necessity of taking into account this difference in conducting quantitative neutrino experiments.

NUCLEAR THEORY

1743 Proximity forces. Blocki, J.; Randrup, J.; Swiatecki, W.J.; Tsang, C. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). **105**: No. 2, 427-462(Jun 1977).

We have generalized a theorem according to which the force between two gently curved objects in close proximity is proportional to the interaction potential per unit area between two flat surfaces made of the same material, the constant of proportionality being a measure of the mean curvature of the two objects. This theorem leads to a formula for the interaction potential between curved objects (e.g., two smooth cylinders of mica or two atomic nuclei) which is a product of a simple geometrical factor and a universal function of separation, characteristic of the material of which the objects are made, and intimately related to the surface energy coefficient. We have calculated and tabulated this universal function for nuclear surfaces, using the nuclear Thomas- Fermi approximation. The results can be expressed by a simple cubic-exponential formula which gives the potential between any two nuclei in the separation degree of freedom. Even simpler expressions are found for the interaction energy associated with the "crevice" or neck in the nuclear configuration that would be expected immediately after contact of two nuclei. These "proximity energies" are used to supplement the usual expansion of the energy of a thin-skinned system into volume, surface, curvature, and higher-order terms. The resulting elementary formulas are tested against explicit models of interacting nuclei and against elastic scattering data, and are found to be useful for even quite small mass numbers.

NUCLEAR STRUCTURE

REFER ALSO TO CITATION(S) 1746

NUCLEAR MATTER

1744 (COO—3069-534) **Nuclear matter theory.** Negele, J.W. 1977. Contract EY-76-C-02-3069. 24p. (OSP—77906; CONF-770674—3). Dep. NTIS, PC A02/MF A01.

From Nucleon-nucleon interaction meeting; Vancouver, Canada (27 Jun 1977).

Recent advances in variational and perturbative theories are surveyed which offer genuine promise that nuclear matter will soon become a viable tool for investigating nuclear interactions. The basic elements of the hypernetted chain expansion for Jastrow variational

functions are briefly reviewed, and comparisons of variational and perturbative results for a series of increasingly complicated systems are presented. Prospects for investigating realistic forces are assessed and the unresolved, open problems are summarized.

NUCLEAR REACTIONS AND SCATTERING

1745 (BNL—22834) **Role of the Pauli principle in pion—nucleus scattering.** Dover, C.B. May 1977. Contract EY-76-C-02-0016. 17p. (CONF-770452—1). Dep. NTIS, PC A02/MF A01.

From Workshop on pion-nucleus scattering; College Park, Maryland, United States of America (USA) (22 Apr 1977).

The role of the Pauli principle in pion-nucleus scattering is studied using many-body theory with propagators. The objective is to calculate the pion self energy in the nucleus from an effective πN amplitude which is density dependent. It is concluded that the Pauli effect on the optical potential is small (5% level), that first order hole line expansion for the effective amplitude is inappropriate, and that particle and hole propagation must be treated symmetrically. 2 references. (JFP)

1746 (BNL—23062) **Nuclear photoelectric effect and remarks on higher multipole transitions.** Goldhaber, M. 1977. Contract EY-76-C-02-0016. 32p. (CONF-770580—1). Dep. NTIS, PC A03/MF A01.

From Symposium on the history of nuclear physics; Minneapolis, Minnesota, USA (18 May 1977).

The history of the nuclear photoeffect is reviewed from a personal point of view. (JFP)

1747 (LA-UR—77-1031) **Cross sections in the energy range from 10 to 40 MeV calculated with the GNASH code.** Arthur, E.D.; Young, P.G. 1977. Contract W-7405-ENG-36. 22p. (CONF-770523—5). Dep. NTIS, PC A02/MF A01.

From Symposium on neutron cross sections 10-40 MeV; Upton, New York, United States of America (USA) (3 May 1977).

A brief description of the preequilibrium-statistical model code GNASH is given. Features which make the code applicable to the calculation of cross sections induced by nucleons of energy 40 MeV or less are described. Finally, examples of calculations of neutron- and proton-induced reaction cross sections, activation cross sections, and secondary spectra made with global input parameters are given.

1748 (ORNL/TM—5710) **High energy (E $\leq$ 1000 GeV) intranuclear cascade model for nucleons and pions incident on nuclei and comparisons with experimental data.** Bertini, H.W.; Culkowski, A.H.; Hermann, O.W.; Gove, N.B.; Guthrie, M.P. Aug 1977. Contract W-7405-ENG-26. 64p. Dep. NTIS, PC A04/MF A01.

An intranuclear cascade model for reactions of pions and nucleons with complex nuclei that should cover the energy range from about 50 MeV to about 1000 GeV was developed. The model includes the effect of a diffuse nuclear surface, the Fermi motion of the bound nucleons within the nucleus, the exclusion principle, a local potential for nucleons, a localized reduction in the density of the nucleus during the development of the cascade, and the sequencing of the events correctly with time. Theoretical results from the model are compared with experimental data over the energy range approximately 3 to 1000 GeV. Within the cascade model, the equations that are used to represent the pion multiplicity from the reactions of nucleons and pions with the individual nucleons of the nucleus underestimates the number of shower particles produced by these individual nucleon interactions. In spite of this the predicted number of shower particles escaping from the nucleus, for 100-GeV nuclear interactions, is overestimated by about 25 percent for light nuclei to about 60 percent for heavy nuclei. The agreement for the number of escapes from the nucleus is somewhat better at lower interaction energies (approximately 10 to 20 GeV). Some of the major trends in the observed high-energy data are predicted quite well. These include the energy independence of the number of black tracks produced at interaction energies above 5 GeV, the number of shower particles produced above 100 GeV, and the radionuclides produced above 10 GeV. Other trends that are predicted fairly well are the small mass dependence of the shower particle multiplicity and the change in the angular dependence of the multiplicity with mass. In absolute comparisons, the predicted total reaction cross sections are in good agreement with experimental data, and the cross sections for the production of radionuclides are in fair agreement. 14 figures, 5 tables.

1749 **Bound-state momentum distributions.** Alexander, Y.; Redish, E.F.; WallN.S. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). **16**: No. 2, 526-528(Aug 1977).

Proposed forms for nuclear momentum distributions are investigated. Calculations of (p,p') reactions using those forms are done in a plane-wave impulse approximation at angles where the quasielastic peak is seen and also at back angles. The parameters used are derived from (e,e') data, where the nuclear momenta probed overlap with those of the low angle (p,p') experiment. Although there is reasonable agreement for the (p,p') data at 180°, the inclusion of distortion necessitates a different parameter set to obtain agreement for the quasifree process. We conclude that the (p,p') reaction cannot be readily understood with a simple momentum distribution.

1750 **Correlation expansion of the optical potential.** Ernst, D.J.; Londergan, J.T.; Miller, G.A.; Thaler, R.M. (Physics Department, Case Western Reserve University, Cleveland, Ohio 44106). **16**: No. 2, 537-555(Aug 1977).

The multiple scattering theory for the optical potential is examined. This series is arranged according to the number of target particles struck in forming the optical potential. The term which involves two target particles is summed as a three-body problem. Explicit formulas for calculating the optical potential in the fixed scatterer approximation are presented. Corrections to the fixed scatterer approximation, one a correction to closure, another a correction due to nonlocality in the two-body interaction, are presented. The relation between this work and other formal,rearrangements of the multiple scattering series is presented.

1751 **Effects of bound-state approximations on distorted-wave Born approximation and multistep processes in the channel-coupling-array theory.** Kouri, D.J.; Levin, F.S. (Departments of Chemistry and Physics, University of Houston, Houston, Texas 77004). **16**: No. 2, 556-563(Aug 1977).

The effects of approximating the equations of the channel-coupling-array theory by retaining only bound internal states of the clusters in two-body channels are studied. This approximation corresponds to those used in standard direct nuclear reaction calculations. By use of Lippmann's identity, the exact channel-coupling-array equations may be written in two alternate forms (different off-shell extensions) which respond differently to the bound-state approximation. When the bound state approximation is made on the equations in "folded" form, its main effect is that the distorted-wave Born approximation occurs in only one of the two-body channels, a modified distorted-wave Born approximation occurs in another, and no first order amplitudes of any kind occur in the remaining channels. If Lippmann's identity is first used to unfold the exact channel-coupling-array equations (thereby yielding a different off-shell extension) and then the bound state approximation is applied, distorted-wave Born approximation amplitudes are found in all channels. The need for accurate, nonperturbative solutions to the approximate equations so as to assess the effects of possible low-order approximations is stressed.

1752 **Interaction times for damped heavy-ion collisions.** Schroeder, W.U.; Birkelund, J.R.; Huizenga, J.R.; Wolf, K.L.; Viola, V.E. Jr. (Nuclear Structure Research Laboratory and Departments of Chemistry and Physics, University of Rochester, Rochester, New York 14627). **16**: No. 2, 623-628(Aug 1977).

Angular-momentum dependent interaction times for damped heavy-ion reactions are deduced from experimental angular distributions. The angular momentum l is related to the experimental kinetic-energy loss assuming the energy loss to increase monotonically with decreasing l and the experimental cross section to be given by the sharp cutoff model. Although the analysis depends on the moment of inertia of the intermediate double-nucleus system, rather short interaction times are obtained ranging from 10^{-22} to several times 10^{-21} sec. Assuming this time scale, nucleon diffusion coefficients are deduced from experimental fragment charge distributions.

1753 **Nucleon form factors, Lorentz invariance, and nuclear photoabsorption.** Friar, J.L.; Fallieros, S. (Department of Physics, Brown University, Providence, Rhode Island 02912). **16**: No. 2, 908-911(Aug 1977).

The role of the intrinsic nucleon size in a phenomenological treatment of photon absorption by a nucleus is discussed. It is suggested that the complete transition matrix element should be written as a product of the purely nuclear matrix element and the intrinsic nucleon form factor. The latter is written as a function, not of q^2 (the four-momentum transfer), but of $q^2 + \omega^2$, where ω is the excitation energy of the nucleus. We note that for real photons where $q^2 = 0$ this is essentially equivalent to q^2, i.e., the three-momentum transfer.

1754 **Valence—doorway model for radiative capture.** Lev, A.; Beres, W.P. (Wayne State University, Department of Physics, Detroit, Michigan 48202). **106**: No. 2, 322-341(Aug 1977).

A model of radiative capture is presented in which the T-matrix for valence capture is expressed as the sum of three terms, viz., a direct capture term, a term that describes the coupling between a single-particle resonance and the many possible continuum channels, and a pure single-particle resonance term. Expressions for the target excitations are not explicitly included, and projection operators are used to break up the single-particle space into resonant and nonresonant parts. The spreading of single-particle resonances is described through the coupling to particle-vibration doorways. The model is applied to the cases of ^{98}Mo(n,γ) ^{99}Mo and ^{92}Mo(n,γ) ^{93}Mo for an energy range of 0—3 MeV. In these cases the single-

particle resonance amplitude is overwhelmingly dominant, and doorway effects are found to be relatively unimportant. Radiative widths obtained from our calculated average cross sections are compared to the corresponding widths obtained by averaging over the detailed fine structure measurements of Chrien et al. for ^{99}Mo. Good agreement is obtained. The valence capture cross section in ^{93}Mo is considerably smaller than in ^{99}Mo. This is consistent with the measurements of Chrien et al. and in good agreement with a recent analysis by Soloviev and Voronov.

1755 Strength distributions and statistical spectroscopy. I. General theory. Draayer, J.P.; French, J.B.; Wong, S.S.M. (Department of Physics and Astronomy, Louisiana State University, Baton Rouge, Louisiana 70803). **106**: No. 2, 472-502(Aug 1977).

The strength distribution for an arbitrary excitation is given in terms of a double expansion, and its sum rules by single expansions, in polynomials defined by the initial and final energy spectra. In model spaces which are not too large, a rapid convergence, to within fluctuations, is assured by the action of a central limit theorem, as is shown in particular by considering the response of the system under infinitesimal deformations of the Hamiltonian. When larger spaces are decomposed into subspaces defined by a partitioning of the single-particle space a similar convergence results. At the same time, close contact is made with, and important corrections are found to, intuitive procedures which are often used for approximating strength distributions. The general features of the distribution are often easily understood in terms of a simple geometry made effective in the model space by the central limit theorem, and further features by exploiting the connection of this geometry to the unitary group of transformations in the single-particle space. Extensions are given for multipole strengths and sum rules, appropriate when the angular momenta (and isospins) are specified for the states involved in the transitions. Measures for the RMS fluctuations in the sum-rule quantities, and correlations between them, are given by combining the low-order-polynomial (statistically smoothed) strengths with an assumed Porter—Thomas distribution for the (high-order) strength fluctuations.

1756 Strength distributions and statistical spectroscopy II. Shell-model comparisons. Draayer, J.P.; French, J.B.; Wong, S.S.M. (Department of Physics and Astronomy, Louisiana State University, Baton Rouge, Louisiana 70803). **106**: No. 2, 503-524(Aug 1977).

The theory of the preceding paper is applied to a number of M1, E2, and E4 electromagnetic excitations in the $(ds)^6$ space. Comparisons are made in detail with shell-model results for the pth energy-weighted sum rules, with p=0,1,2 and starting states spanning the entire spectra, as well as with the exothermic—endothermic decomposition of the nonenergy weighted sum rule, and the RMS fluctuations in, and correlations between, the sum-rule quantities. Further comparisons are made for the strength distributions themselves. In all cases the agreements are good, for the sum rules remarkably so, so that the statistical theory describes very well the essential features of the strength distribution. The only (partial) exception is with the usual low-lying quadrupole collectivity found microscopically for two of the starting states (for which most of the strength goes to a single final state) and predicted, though not in such detail, via a statistical calculation of the effective number of final states available for the quadrupole transitions. We are seeing here a real coexistence of collective and statistical phenomena. At higher excitations, where concentration of much of the strength into a single state is not to be expected, all the essential features should be statistically describable. As a result of the comparisons, we expect that the statistical theory, supplemented by further methods for the evaluation of the necessary input traces, should give an almost complete account of the essential features of the strength distributions, even in model spaces of arbitrarily large dimensionality.

1757 Inverse-scattering-problem model in nuclear physics. Zakhar'ev, B.N.; Mel'nikov, V.N.; Rudyak, B.V.; Ushakov, I.B. (Joint Institute for Nuclear Research). **25**: No. 2, 161-163(Feb 1977).

Simple recurrence relations are obtained which enable us to reconstruct the interaction in the finite-difference approximation for the Schroedinger equation from scattering data (without solving equations of the Gel'fand-Levitan type).

1758 Effect of nucleon electromagnetic structure on the differential cross sections for the scattering of electrons by nuclei. Afanas'ev, G.N.; Shilov, V.M.; Eliseev, S.M. (Joint Institute for Nuclear Research). **25**: No. 2, 164-166(Feb 1977).

The importance of taking account of the electromagnetic structure of nucleons is shown in connection with the interpretation of experimental data on the elastic scattering of electrons by nuclei within the framework of the single-particle model. The calculations indicate that taking account of the neutron's electromagnetic structure leads to a change of the cross section by an amount of the order of 20%.

1759 Isospin restrictions on the spin-density matrix of quasi-two-particle reactions [0/sup -1/2+/→0/sup -3/2+/]. Ion, D.B. (Joint Institute for Nuclear Research). **25**: No. 2, 247-248(Feb 1977).

Sum rules are used to calculate isospin limitations on the spin density matrices of quasi-two-particle reactions connected with spin invariance via two channels. These restrictions are important in analyzing experimental data.(AIP)

SPONTANEOUS AND INDUCED FISSION

1760 Spin of target nucleus and angular anisotropy of fission. Tishin, A.S.; Istekov, K.K.; Ermagambetov, S.B.; Smirenkin, G.N. (Physics and Power Engineering Institute). **25**: No. 2, 147-150(Feb 1977).

The effect of the target-nucleus spin on the anisotropy of fragment emission is considered in the quasiclassical approximation of the statistical theory of the angular anisotropy of fission. It is shown that this effect is sensitive to the assumptions made concerning the dependence of the fission probability on the angular momentum, and it is this which causes the discrepancies in earlier studies.

NUCLEAR MODELS

1761 Is it safe to use the unitary pole expansion for hard core potentials. Mantri, A.N.; Lagu, A.V. (Department of Physics, Banaras Hindu University, Varanasi 221005, India). **16**: No. 2, 912-916(Aug 1977).

We have examined the various terms in the unitary pole expansion for a hard core potential. It is found that the goodness of the unitary pole expansion depends upon the number of positive and negative eigenvalues in the expansion. It is doubtful if the unitary pole expansion improves over the one term approximation in such a case.

RADIATION AND SHIELDING PHYSICS

SHIELDING CALCULATIONS AND EXPERIMENTS

REFER ALSO TO CITATION(S) 676, 759, 1259

NEUTRON INTERACTIONS WITH MATTER

REFER ALSO TO CITATION(S) 2007

1762 (UCRL—78560) Radiation doses as a function of the thickness and shielding material surrounding a 14-MeV neutron source. Hansen, L.F.; Komoto, T.; Wong, C. Apr 1977. Contract W-7405-ENG-48. 9p. (CONF-770401—23). Dep. NTIS, PC A02/MF A01.

From 5. international conference on reactor shielding; Knoxville, Tennessee, United States of America (USA) (18 Apr 1977).

The neutron and gamma does for tissue approximation resulting from a 14-MeV neutron source have been calculated as a function of the shielding material and its thickness surrounding the source. The calculations have been carried out for water, concrete, and iron, for thicknesses varying between one and ten mean free paths (mfp). The calculated neutron and gamma spectra emerging from the spherical shielding materials have been compared with measurements for 1.1 to 2.0 mfp of water, 2.1 and 3.9 mfp of concrete and 0.9, 2.9 and 4.8 mfp of iron. These measurements have been carried out using the sphere transmission and time-of-flight techniques. The calculations of the neutron and gamma spectra from the spherical assemblies, as well as the tissue kerma factors (TKF) as a function of emitted energy, have been done using two libraries: the ENDF/B-IV and the ENDL. Differences between the calculated kerma factors are not larger than 6 percent using the two libraries. Comparison of the above kerma factors with earlier values (Henderson, 1959, NBS, 1961) shows differences as large as 20 percent. The tissue gamma dose (TGD) calculations have been done using the values given by NBS, 1961; these values are approximately 10 percent lower than those given by Henderson.

1763 Multiregion problems in plane geometry. Ishiguro, Y. (Instituto de Energia Atomica, Sao Paulo, Brazil). **26**: 224(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

1764 Two-media Milne problem in two-group neutron transport theory. Ishiguro, Y. (Instituto de Energia Atomica, Sao Paulo, Brazil). **26**: 224-225(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

1765 Conjugate gradient solutions to the discrete ordinates equations. Lewis, E.E. (Los Alamos Scientific Lab., NM). **26**: 225-226(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

1766 Epithermal 1/V self-shielding using the Nordheim Integral Treatment. Lewallen, M.A.; Trapp, T.J. (Battelle Pacific Northwest Lab., Richland, WA). **26**: 231-232(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

1767 Determining equal probability steps for Monte Carlo elastic angular data. Grimesey, R.A.; Watanabe, T. (EG and G Idaho, Inc., Idaho Falls, ID). **26**: 234-235(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

MEDICAL PHYSICS

RADIATION PROTECTION STANDARDS

1768 First amendment of the 'Guidelines for radiation protection examinations according to subsection 1 of section 4 of the X-ray Ordinance'. No. 2, 53-54(Feb 1977). (In German).

Some amendments of technical radiation protection precautions, such as measurement of the local dose rate, useful beam, examination of mobile X-ray equipment for implementing the X-ray Ordinance.

SOLID STATE PHYSICS

1769 Multishell method: Exact treatment of a cluster in an effective medium. Gonis, A.; Garland, J.W. (University of Illinois, Chicago, Illinois 60680). **16**: No. 6, 2424-2436(15 Sep 1977).

A method is presented for the exact determination of the Green's function of a cluster embedded in a given effective medium. This method, the multishell method, is applicable even to systems with off-diagonal disorder, extended-range hopping, multiple bands, and/or hybridization, and is computationally practicable for any system described by a tight-binding or interpolation-scheme Hamiltonian. It allows one to examine the effects of local environment on the densities of states and site spectral weight functions of disordered systems. For any given analytic effective medium characterized by a non-negative density of states the method yields analytic cluster Green's functions and non-negative site spectral weight functions. Previous methods used for the calculation of the Green's function of a cluster embedded in a given effective medium have not been exact. The results of numerical calculations for model systems show that even the best of these previous methods can lead to substantial errors, at least for small clusters in two- and three-dimensional lattices. These results also show that fluctuations in local environment have large effects on site spectral weight functions, even in cases in which the single-site coherent-potential approximation yields an accurate overall density of states.

1770 Photoionization of 4f electrons from rare-earth atoms at a surface. Feibelman, P.J.; McGuire, E.J. (Sandia Laboratories, Albuquerque, New Mexico 87115). **16**: No. 6, 2927-2933(15 Sep 1977).

Measurement of photocurrent versus frequency of 4f electrons from surface-rare-earth atoms is proposed as a means for identifying refraction effects in photoelectron spectroscopy. The idea of using surface-rare-earth-atom 4f electrons takes advantage of the fact that since their wave functions are atomiclike (even though their binding energies are typically only a few eV) any unusual behavior of the photoyield versus frequency will not be ascribable to poorly known surface-electron wave functions, but will have to be associated with dielectric interface effects. Jellium-model calculations are presented which show qualitatively how surface dielectric phenomena should appear in the frequency variation of the ratio of photoyields with p-polarized and s-polarized light.

1771 Interference parameters in γ-ray optics. Goldwire, H.C. Jr.; Hannon, J.P. (Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87544). **16**: No. 5, 1875-1888(1 Sep 1977).

Calculations are given for the interference (or "screening") parameters ξ (Lλ) arising in low-energy γ-ray optics. In γ-ray emission, these parameters arise from the interaction of the emitted photon with the surrounding electron cloud of the atom, giving a phase shift to the emitted photon which depends on the multipolarity of the nuclear transition. In γ-ray absorption experiments, the parameters specify the effects of the interference between photoelectron and internal-conversion electron absorption, and the interference between nonresonant scattering from the atomic electrons and resonant scattering from the nucleus. These interference effects give arise to a dispersion term in the total cross section, thereby producing a small asymmetry in the absorption spectrum and slightly shifting the center of the absorption line. These effects can be very important in determining precise isomer shifts and in analyzing Moessbauer tests of time-reversal invariance. We present calculated screening parameters for E1, M1, and E2 γ-ray transitions, and we examine their dependences on the nuclear charge and the γ-ray energy. We compare the results with the available experimental determinations.

1772 Critical and tricritical behavior in the hierarchical model. Baker, G.A. Jr.; Golner, G.R. (Theoretical Division, University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). **16**: No. 5, 2081-2094(1 Sep 1977).

The hierarchical model is solved exactly, numerically in the presence of a magnetic and a staggered magnetic field. Critical and tricritical behavior is studied. The general picture of Riedel and Wegner is confirmed. It is shown that their logarithmic corrections are unobservable owing to the interference of higher-order corrections.

1773 Ising models with n > or = 2-component order parameters. Krinsky, S.; Mukamel, D. (Department of Physics, Brookhaven National Laboratory, Upton, New York 11973). **16**: No. 5, 2313-2318(1 Sep 1977).

The dimensionality of the order parameters of several spin-1/2 Ising models with competing interactions is discussed. It is argued that many such models are described by n > or = 2 component order parameters.

1774 Theory of one-dimensional hopping conductivity and diffusion. Richards, P.M. (Sandia Laboratories, Albuquerque, New Mexico 87115). **16**: No. 4, 1393-1409(15 Aug 1977).

Hopping motion is considered in a linear equation containing an arbitrary density of particles that are not allowed to hop to occupied sites. The general case of two inequivalent lattice sites A and B is treated. Transition-rate equations are solved by Monte Carlo simulation and, where possible, by analytic techniques. Only for the case of equivalent sites do the results here agree with those recently obtained by Huber from nonlinear differential equations for site occupancy which neglect certain correlations. The conductivity is mean-field-like for equivalent sites, but shows sizeable departure for inequivalent sites, having an activation energy increased over the mean-field value. Here "mean-field" behavior is one where the only effect of forbidden hops to occupied sites is to reduce effective transition rates by a factor 1 - n, where n is the average occupation number of the site to which a jump occurs. The velocity correlation function is shown to consist of a δ-function part which reproduces the mean-field conductivity and a function β (t) which is negative for times t > 0. This is qualitatively quite different from the picture given by Huber's equations. Motion of a single distinguishable particle shows an anomalous x^2 proportional t/sup 1/2/ dependence of the mean square displacement upon time t, but the displacement X of all the particles does obey a diffusion relation X^2 proportional t. This difference is explained in terms of the number of particles which have to be pushed aside in order for a particle to move a distance x, and in terms of the ensuing density fluctuation. Differences between time dependences and attempt fequencies as measured by bulk conductivity and microscopic probes such as NMR are noted and discussed in light of data on the one-dimensional superionic conductor β eucryptite ($LiAlSiO_4$). Reinterpretation of NMR relaxation data on some of the organic charge-transfer salts is also suggested.

1775 Estimates of the ground-state eigenvalue of the two-dimensional spin-1/2 X-Y model. Pearson, R.B. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). **16**: No. 3, 1109-1111(1 Aug 1977).

An estimate as well as upper and lower bounds are presented for the ground-state energy density per spin of the two-dimensional spin-1/2 X-Y model on a square lattice. The energy density is estimated to be $\epsilon_0 = -1.099 +- 0.004$ and is bounded by $-1.12498 < \text{or} = \epsilon_0 < \text{or} = -1.09440$.

1776 Demagnetizing fields in the de Haas—van Alphen effect. Crabtree, G.W. (Argonne National Laboratory, Argonne, Illinois 60439). **16**: No. 3, 1117-1125(1 Aug 1977).

A description of magnetic interaction, including demagnetizing effects and the vector nature of the magnetization, is presented. Demagnetizing factors appropriate for the second-order approximation for cubic and cylindrical sample shapes are explicitly calculated. A technique for measuring absolute amplitudes based on the weak interaction of two frequencies is proposed.

1777 Interstitial solute diffusion in metals. Murch, G.E.; Thorn, R.J. (Argonne National Lab., IL). **38**: No. 7, 789-793(1977).

The diffusion of interstitial solute atoms, which were subject to nearest-neighbor solute—solute interactions, was simulated by

means of a modified Monte Carlo method. Solute correlation factors, nearest-neighbor vacancy availability factors, and effective jump frequency factors were calculated as functions of composition and temperature. Compared with that between noninteracting atoms, attraction between solute atoms always retarded diffusion, whereas repulsion always enhanced diffusion except within the ordered region. 5 figures.

SUPERCONDUCTIVITY

GENERAL THEORY

1778 Isotope effect in superconducting compounds: PdH. Morozov, A.I. (Moscow Physicotechnical Institute). **19**: No. 5, 867-868(May 1977).

It is shown that the frequency of acoustic phonons in a superconducting compound does not change as the mass of the lighter component varies.(AIP)

1779 Effect of nonmagnetic impurities on nuclear spin relaxation in superconductors. Vladimir, M.I.; Serdyuk, A.D. (A. M. Gor'kii Kharkov State University). **3**: No. 2, 67-70(Feb 1977).

The results of a calculation of the rate of spin—lattice relaxation of nuclear magnetic moments in two-band semiconductors with nonmagnetic impurities are described. Small and large nonmagnetic impurity densities are considered. In both cases a logarithmic contribution of the concentration-dependent term in the rate of relaxation is obtained. When the impurity density approaches zero there is a logarithmic divergence characteristic for the corresponding expression in a pure superconductor following from the Bardeen-Cooper-Shrieffer theory.

1780 Current-voltage characteristics of low-capacitance Josephson junctions. Zorin, A.B.; Likharev, K.K. (Moscow State University). **3**: No. 2, 70-71(Feb 1977).

The current-voltage characteristics of a low-capacitance Josephson junction are calculated on the basis of the well developed theory of the Josephson effect in tunnel junctions. The possibility of applying this theory to a description of Josephson junctions with indirect conductivity is evaluated.

ACOUSTIC, ELECTRIC, MAGNETIC, OPTICAL, AND THERMAL PHENOMENA

REFER ALSO TO CITATION(S) 1106, 1131, 1152

THEORETICAL PHYSICS

1781 Fermi-hypernetted-chain methods and the ground state of fermion matter. Zabolitzky, J.G. (Argonne National Laboratory, Argonne, Illinois 60439). **16**: No. 3, 1258-1283(Sep 1977).

The convergence properties of the Fermi-hypernetted-chain method as originated by Fantoni and Rosati are investigated. Numerical results are reported for liquid ^{3}He and two model fermion liquids. It turns out that for not too high densities and not too long-ranged correlation functions the convergence to an upper bound for the ground-state energy is excellent, but that for higher densities and/or long-ranged correlation functions, it is easily possible to underestimate the upper bound if one does not apply certain convergence criteria and associated error estimates.

CLASSICAL AND QUANTUM MECHANICS

REFER ALSO TO CITATION(S) 1745

1782 Time-dependent scattering of wave packets in one dimension. Hammer, C.L.; Weber, T.A.; Zidell, V.S. (Ames Laboratory—ERDA and Department of Physics, Iowa State University, Ames, Iowa 50011). **45**: No. 10, 933-941(Oct 1977).

This paper treats the scattering of wave packets in one space dimension at the mathematical level of the first-year graduate student. The analytic properties of the general-scattering solutions are emphasized, thereby making the analysis useful as introductory material for a more sophisticated S-matrix treatment. Resonant scattering, time delay, and line shape, as well as the relationship between bound and resonant states, all follow as a natural consequence of the analysis.

1783 Rutherford revisited: Deflection of an electron in inverse first-, second-, and third-power central fields. Hubbell, H.H. Jr.; Birkhoff, R.D.; Allen, J.D. (Health Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). **45**: No. 9, 826-832(Sep 1977).

The classical scattering equation for a charged particle moving in a plane perpendicular to the axis of inverse first- (cylindrical), second- (spherical), and third-power central fields has been solved by a general computer program for the experimental case of a bounded field. The particle enters with a known energy and impact parameter through a hole in a grounded electrode having a large but finite radius, and exits at the same radius after passing by a very small central electrode having a given potential. Results were computed and plots are given for the distances of closest approach of the particle to the scattering center, and the exit angles for the three cases for a large range of impact parameters and ratios of applied potential to initial energy. Our computer results for the spherical field check analytic solutions for Rutherford α particle scattering.

1784 Time evolution of unstable quantum states and a resolution of Zeno's paradox. Chiu, C.B.; Sudarshan, E.C.G.; Misra, B. (Center for Particle Theory, Department of Physics, The University of Texas, Austin, Texas 78712). **16**: No. 2, 520-529(15 Jul 1977).

The time evolution of quantum states for unstable particles can be conveniently divided into three domains: the very short time where Zeno's paradox is relevant, the intermediate interval where the exponential decay holds more or less, and the very long time where the decay is governed by a power law. In this work, we reexamine several questions relating to the deviations from the simple exponential decay law. On the basis of general considerations, we demonstrate that deviations from exponential decay near $t = 0$ are inevitable. We formulate general resonance models for the decay. From analytic solutions to specific narrow-width models, we estimate the time parameters T_1 and T_2 separating the three domains. The parameter T_1 is found to be much much less than the lifetime Γ^{-1}, while T_2 is much greater than the lifetime. For instance, for the charged pion decay, $T_1 \sim 10^{-14}/\Gamma$ and $T_2 \sim 190/\Gamma$. A resolution of Zeno's paradox provided by the present consideration and its limitations are discussed.

RELATIVITY AND GRAVITATION

1785 Regularization of the stress-energy tensor for vector and scalar particles propagating in a general background metric. Adler, S.L.; Lieberman, J.; Ng, Y.J. (The Institute for Advanced Study, Princeton, New Jersey 08540). **106**: No. 2, 279-321(Aug 1977).

We study the regularization of the stress-energy tensor for massless vector and massless and massive scalar particles propagating in a general background metric, using covariant point-separation techniques. We find a prescription which leads to a stress-energy tensor which is conserved (provided, in the scalar case, that zeta=1/6) and which is traceless in the conformal invariant limit. The prescription, however, is not a unique one, since the conventionally renormalized stress-energy tensor contains an undetermined multiple of a term, which can be formally reinterpreted as arising from an addition to the gravitational action which is quadratic in the Weyl curvature tensor.

ACOUSTICS

1786 Control of vocal-tract length in speech. Riordan, C.J. (Phonology Laboratory, University of California, Berkeley, California). **62**: No. 4, 998-1002(Oct 1977).

Essential for the correct production of vowels is the accurate control of vocal-tract length. Perkell [Psychology of Speech Production (MIT, Cambridge, MA, 1969)] has suggested that two important determinants of vocal-tract length are vertical larynx position and lip spreading/protrusion, often acting together. The present study was designed to determine whether constraining lip spreading/protrusion induces compensatory vertical larynx displacements, particularly on rounded vowels. Upper lip and larynx movement were monitored photoelectrically while French and Mandarin native speakers produced the vowels /i,y,u/ first under normal-speech conditions and then with lip activity constrained. Significant differences were found in upper-lip protrusion and larynx position depending on the vowel uttered. Moreover, the generally low-larynx position of rounded vowels became even lower when lip protrusion was constrained. These results imply that compensatory articulations contribute to a contrast-preserving strategy in speech production.

OPTICS

1787 Longitudinal and transverse displacements of a bounded microwave beam at total internal reflection. Cowan, J.J.; Anicin, B. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). **67**: No. 10, 1307-1314(Oct 1977).

Longitudinal and transverse shifts of an 8 cm parallel bounded beam of 34.2 GHz (8.77 mm) microwaves totally reflected from a paraffin prism have been investigated. The 45° - 45° - 90° prism is 18 cm high by 25 cm on the sides and the index of refraction is 1.491. Longitudinal shifts as large as 3 cm have been measured in a single reflection near the critical angle for a beam linearly polarized in the plane of incidence. The shift for perpendicular polarization is approximately half this value. The results are in general agreement with the classical theory for the Goos-Haenchen effect. An incident

beam polarized at 45° to the incidence plane produces both parallel and perpendicular polarization shifts with values similar to the above. The shifts for both polarizations are reduced but are still distinctly separate if either a second prism or a metallic reflector is brought into the evanescent wave at millimeter distances from the interface. These results are in accordance with stationary phase calculations for two interfaces. It is found that a small (6 mm) transverse shift results if the prism is illuminated with circularly polarized microwaves.

STATISTICAL PHYSICS AND THERMODYNAMICS

1788 Theory for site—site pair distribution functions of molecular fluids. Johnson, E. (Chemistry Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). **67**: No. 7, 3194-3205(1 Oct 1977).

A theory for site—site pair distribution functions of molecular fluids is presented. This theory is analogous to the RISM theory, but it is not restricted to interaction site pair potentials. It was derived directly from the Ornstein—Zernike equation using Fourier—Wigner series. Results of the theory for homonuclear diatomic pair potentials are compared with corresponding results obtained from the RISM theory and from computer simulation studies. The relationship between the RISM equation for homonuclear hard sphere diatomic pair potentials and the theory presented is given.

1789 One-dimensional Ising model in arbitrary external field. Percus, J.K. (Courant Institute of Mathematical Sciences and Physics Department, New York University, New York, New York). **16**: No. 3, 299-309(Mar 1977).

The external potential needed to produce an arbitrary equilibrium density profile for a one-dimensional lattice gas with nearest neighbor interactions is solved exactly. The resulting sequence of direct correlation functions is shown to be of short range, and in the ferromagnetic case the even members alternate in sign at zero spin. The even Ursell distributions in this case likewise alternate in sign.

ELECTRICITY AND MAGNETISM

1790 Determining a subsurface electromagnetic profile fom high-frequency measurements by applying reconstruction-technique algorithms. Lager, D.L.; Lytle, R.J. (Univ. of California, Livermore). **12**: No. 2, 249-260(1977).

The data-inversion algorithms developed by investigators in the field of tomography to the problem of determining the structure of the ground between a pair of drill holes. The three most successful algorithms to date have been modified versions of the tomographer's ART (algebraic reconstruction technique), SIRT (simultaneous iterative reconstruction technique) and BPT (back projection technique). Projections were made by probing the ground with high frequency radio waves and recording the magnitude and phase of the received signal for various positions of transmit and receive antennas. The region between the holes was divided into rectangular zones (like a checkerboard). Ray-optic approximations were made so that the equations describing the propagation between transmitter and receiver reduced to a linear system. The reconstruction technique algorithms were used to solve the system iteratively and assign appropriate values of skin depth to each zone. Simulations of a geological situation of interest were done to assess the sensitivity of the algorithms to noisy data. Then, measurements were taken in a coal field and the data were reduced using the ray-optic assumptions and solution by the various algorithms.

FUSION ENERGY

PLASMA RESEARCH

1791 Three-dimensional structure of an isothermal supersonic Ar: Cs plasma stream under conditions of strong MHD interaction. Baranov, V.Y.; Vedenov, A.A.; Kuleshov, V.P.; Lyubimov, B.Y.; Malyuta, D.D.; Mezhevov, V.S. (I. V. Kurchatov Atomic Energy Institute). **14**: No. 6, 1150-1157(May 1977).

Braking by means of a magnetic field of a supersonic, isothermal Ar: Cs plasma is studied. The experimental conditions are such that a linear shock wave is created in a channel. The change in the flow structure associated with the appearance of the shock wave is considered in detail. The change in the Mach number in the channel due to electrodynamic braking is found in terms of the measured values of the pressure and of the flow and field components. Questions related to the existence of weak oblique shock waves connected with the concentration of current at the boundaries of the electrodes are discussed. An estimate is given for the effect of the degree of partitioning on the excitation of the flow in the oblique shock waves.

PLASMA CONFINEMENT AND HEATING

REFER ALSO TO CITATION(S) 1904

1792 (PPPL—1361) **Toroidal plasma time evolution. Part II. Ohmic heating during start-up.** Stoenescu, M. Aug 1977. Contract EY-76-S-02-2735. 57p. Dep. NTIS, PC A04/MF A01.

The toroidal plasma time evolution is being analyzed based on a multiple circuit plasma model. The inductive coupling between plasma and external coils and between various plasma subsections is taken into account. The plasma is considered in quasistatic equilibrium in the magnetic field generated by external coils. More correct transport treatment than in Part I of the present report and consideration of the neutral particles lead to realistic time evolution of the radial skin current and temperature profiles when compared with experiments.

1793 (UCID—17544) **Tandem mirror rate code and cyclic purging of alphas in tandem reactors.** Cohen, R.H. 3 Aug 1977. Contract W-7405-ENG-48. 36p. Dep. NTIS, PC A03/MF A01.

A set of coupled rate equations for densities and energies in a tandem mirror machine have been incorporated into a fast-running code. The code is suitable for parameter-searching and studying time-dependent processes. The code has been used to study buildup of thermalized alphas in a tandem mirror reactor, and cyclic schemes for limiting the alpha population. The principal findings are: Q/sub av/ is drastically reduced as alphas build up from a steady-state in which alphas were artificially eliminated; running in a pulsed mode to clean out alphas improves the time-averaged Q significantly, but not enough; elimination of 80% of the alphas by nonadiabatic loss and running in pulsed mode allows a reasonable time-averaged Q.

1794 (UCID—17576) **Review of electrostatic plugging.** Dolan, T.J. 10 Aug 1977. Contract W-7405-ENG-48. 79p. Dep. NTIS, PC A05/MF A01.

Using electric fields to diminish end losses from open magnetic plasma confinement systems is equivalent to magnetically shielding the grid wires of an electrostatic plasma confinement device. Electrostatically plugged magnetic cusps confine electrons magnetically in the perpendicular direction and electrostatically in the parallel direction, and ions are purely electrostatically confined in both directions. Theoretical estimates have been made of confinement times, electron density, plasma potential, and plasma temperatures. Experimentally, plasmas with $n = 5 \times 10^{12}$ cm^{-3}, T/sub i/ = 1 keV, tau = 5 msec, have been confined by cusp fields of about 10 kG with applied voltages approximately 10 kV. Fusion reactors with (fusion power)/(injection power) identical with Q approximately 5 appear feasible using B approximately 80 kG, applied voltage approximately 300 kV, if extrapolations from present experiments hold. Electrostatically plugged cusps are similar in some ways to Tandem Mirrors, to Tormac, and to SURMAC plasma confinement systems.

1795 Surface multipole guide field for plasma injection. Breun, R.A.; Rael, B.H.; Wong, A.Y. (Department of Physics, University of California, Los Angeles, California 90024). **48**: No. 10, 1262-1268(Oct 1977).

Described here is a surface guide field system which is useful for injection of plasmas into confinement devices. Experimental results are given for 5—25-eV hydrogen plasmas produced by a coaxial discharge (Marshall) gun. It is found that better than 90% of the plasma produced by the gun is delivered to the end of the guide 180 cm away, while the neutral component falls by more than an order of magnitude. For these results the rod current providing the magnetic field had to be large enough to provide at least 1.5-ion gyroradii from the center of the guide to the surface of the inner rod.

1796 Production of field-reversing electron rings by ring stacking. Davis, H.A.; Rej, D.J.; Fleischmann, H.H. (School of Applied and Engineering Physics, Cornell University, Ithaca, New York 14853). **39**: No. 12, 744-747(19 Sep 1977).

In the relativistic-electron-coil—Christa experiment two separate, strong E layers are generated from a single beam pulse, and then combined by moving one of the layers along the tank axis. The "stacking" of two layers with about half of the field-reversal strength each leads to the generation of single E layers with field-reversal strength.

1797 Anomalous fast-particle losses from strong electron rings in qudrupole-stabilized mirror fields. Luckhardt, S.C.; Fleischmann, H.H. (Physics Department and School of Applied and Engineering Physics, Cornell University, Ithaca, New York 14853). **39**: No. 12, 747-750(19 Sep 1977).

Experiments on strong E layers trapped in a magnetic mirror field, B_0, indicate anomalous fast-particle losses when quadrupole Ioffe field components, B/sub Q/, are added. These losses include both loss bursts at critical field-reversal levels δ equivalent $\delta B/B_0$ of $\sim$ 25% and $\sim$ 50% (independent of B/sub Q/ and gas pressure) and enhanced steady-state losses between and above these levels. The anomalous loss rate normalized to the normal collisional loss rate is

independent of the background pressure, but roughly proportional to B/sub Q/ with no evident threshold.

1798 Electron heating by neutral-beam injection in the Oak Ridge tokamak. Murakami, M.; Isler, R.C.; Lyon, J.F.; Bush, C.E.; Berry, L.A.; Dunlap, J.L.; Dyer, G.R.; Edmonds, P.H.; King, P.W.; McNeill, D.H. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). **39**: No. 10, 615-618(5 Sep 1977).

Substantial electron heating by energetic-neutral-beam injection has been observed in Oak Ridge tokamak (ORMAK) plasmas. Impurity radiation is enhanced by injection but only to the degree expect for Ohmically heated discharges with the same total power input to electrons, and the electron heat conduction loss is comparable with that in Ohmically heated plasmas. The scaling of average electron temperature with total power input to electrons is approximately the same with or without injection.

1799 Studies of doublet plasmas in Doublet IIA. Fisher, R.K.; Adcock, S.J.; Baur, J.F.; Brooks, N.H.; DeBoo, J.C.; Freeman, R.L.; Guss, W.C.; Helton, F.J.; Hsieh, C.L.; Jensen, T.H.; Lietzke, A.F.; Lohr, J.M.; Mahdavi, M.A.; Matsuda, K.; Moeller, C.P.; Ohkawa, T.; Ohyabu, N.; Prager, S.C.; Rawls, J.M.; Tamano, T.; Vanek, V.; Wang, T.S. (General Atomic Company, San Diego, California 92138). **39**: No. 10, 622-625(5 Sep 1977).

Doublet plasma have been produced in Doublet IIA using an active field-shaping coil system. Significant increases in the electron density and energy confinement time have been observed for the doublet configuration relative to elliptic and circular plasmas in Doublet IIA.

1800 Stochastic ion heating by a perpendicularly propagating electrostatic wave. Karney, C.F.F.; Bers, A. (Research Laboratory of Electronics and Plasma Fusion Center, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). **39**: No. 9, 550-554(29 Aug 1977).

The motion of an ion in the presence of a constant magnetic field and a perpendicularly propagating electrostatic wave with frequency several times the ion cyclotron frequency is shown to become stochastic for fields satisfying $E/B_0 > 1/4(\Omega/\omega)$/sup 1/3/ ($\omega$/k). This stochasticity condition is independent of how close ω is to a cyclotron harmonic. Applications of current interest in supplementary heating of plasmas with rf power near the lower-hybrid frequency are suggested.

1801 Outlook for electron-cyclotron heating in large tokamaks. Alikaev, V.V.; Dnestrovskii, Y.N.; Parail, V.V.; Pereverzev, G.V. (I. V. Kurchatov Institute of Atomic Energy, Moscow). **3**: No. 2, 127-131(Mar 1977).

In a hot tokamak plasma the primary mechanism for absorption of the energy of electromagnetic waves at a frequency near ω/sub He/ is cyclotron damping in the region with $\omega \approx \omega$/sub He/. Numerical calculations are carried out for the wave trajectories and for the absorption of the wave energy along these trajectories in the semiclassical approximation for existing devices and for the devices of the next generation. If the pumping conditions are chosen correctly, the energy is absorbed at the center of the plasma and is expended on heating the bulk of the electrons.

1802 Additional collisionless mechanism for plasma-resonance dissipation of rf energy. Barinov, V.I. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). **3**: No. 2, 132-136(Mar 1977).

An experimental study has been made of the acceleration of electrons in a plasma under the influence of weak external microwave fields (v/sub E//v/sub Te/ $\sim 10^{-4}$—10^{-2}) with initial conditions corresponding to plasma resonance. A possible mechanism is discussed for this acceleration, involving a disruption of the adiabatic motion of the electrons in the rf field near a singularity.

1803 Charged-particle diffusion during ohmic heating in the Uragan 2 stellarator. Konovalov, V.G.; Kotsubanov, V.D.; Kravchin, B.V.; Navlova, G.P.; Pavlichenko, O.S. (Physicotechnical Institute, Academy of Sciences of the Ukrainian SSR, Khar'kov). **3**: No. 2, 175-180(Mar 1977).

The charged-particle confinement times have been measured during ohmic heating of the plasma in the Uragan 2 stellarator. Experiments were carried out with a helium plasma with an electron density (0.2—1.2) x10^{13} cm^{-3} and electron temperatures up to 300 eV with confining magnetic fields up to 22 kOe. In the intermediate range of electron collision frequencies the particle diffusion is an order of magnitude more rapid than neoclassical diffusion. Possible reasons for this anomalous diffusion are discussed: plasma turbulence due to the gravitational drift instability and a reversal of the trapped-particle "pinch effect."

1804 Hard x-ray emission during ohmic heating in the Uragan 2 stellarator. Pavlichenko, O.S.; Tereshchenko, F.F.; Tonkopryad, V.M. (Physicotechnical Institute, Academy of Sciences of the Ukrainian SSR, Khar'kov). **3**: No. 2, 180-184(Mar 1977).

The hard x-rays generated during ohmic discharges in a stellarator have been studied. The hard x rays (E/sub γ/MeV) are emitted as the result of an interaction of the runaway electrons with the wall of the vacuum chamber. A description is offered for the dynamics of the x-ray activity of the discharges. This description includes the "classical" mechanisms of collisionless transport of energetic electrons to the wall (diffusion of the magnetic lines of force and drifting of the runaway-electron orbits) as well as a mechanism involving the formation of islands and the destruction of magnetic surfaces under conditions such that the tearing-mode instability sets in.

1805 Equilibrium currents in stellerators. Dikii, A.G.; Kuznetsov, Y.K.; Pashnev, V.K.; Tonkopryad, V.M. (Physicotechnical Institute, Academy of Sciences of the Ukrainian SSR, Khar'kov). **3**: No. 1, 2-7(Jan 1977).

The quasisteady currents in the plasma of the Uragan stellarator (Khar'kov Physicotechnical Institute) have been studied by measuring the perturbations of the magnetic field outside the plasma during the rf heating. The plasma properties correspond to a hydrodynamic regime for electrons and a plateau regime for ions. The fundamental harmonic of the longitudinal equilibrium current, j/sub parallel j10/(r)cosphi (m=1,n=0), agrees well with the calculated value $j_{10}(r) = -(2c/Bx)\ \delta P/\delta r$. Other harmonics of the longitudinal current are also detected; their characteristics are quite different from the theoretical predictions for an equilibrium plasma. The largest of these harmonics are the zeroth, $j_0(r)$, the second, $j_{20}(r)\cos 2\text{phi}$ and the kink, $j_{11}(r)\cos(\text{phi-phi})$. Several experimental observations imply that the nonlinear entrainment of electrons by the wave and the deviation of the plasma from an equilibrium state, due to the heating, are important.

1806 Effect of plasma pressure on the properties of a hybrid stellarator. Manzyuk, N.A.; Pyatov, V.I.; Rozhkov, A.M.; Sebko, V.P. (A. M. Gor'kii State University, Khar'kov). **3**: No. 1, 7-9(Jan 1977).

A system in which the second and third harmonics of the helical field are superimposed is studied. The resulting equations reduce to those corresponding to traditional stellarator systems with four and six helical conductors when the appropriate limits are taken. In a hybrid configuration it is possible to raise the maximum plasma pressure, as a result of a displacement of the magnetic axis and by modifying the condition for disruption of the configuration by external kink perturbations.

1807 Effect of rotating rf field on plasma flow through magnetic mirror. Demirkhanov, R.A.; Kirov, A.G.; Raevskii, I.M.; Doroshenko, A.N. (Sukhumi Physicotechnical Institute). **3**: No. 1, 17-20(Jan 1977).

An experimental study has been made of the interaction of a plasma flow with a magnetic mirror in the presence of a rotating dipole rf field. The reflecting capability of the mirror increases when rf fields in the megahertz range at frequencies ω/sub Hi/> or $=\omega$ are used. At an rf field of 120 Oe, the density of the plasma flow crossing the mirror is reduced by a factor of ten. The behavior of the density of the plasma flow crossing the mirror as a function of the strength of the rf field found here agrees with theoretical predictions. This improvement of the reflecting capability of the mirror can be used to increase the plasma confinement time in mirror systems.

1808 Limitations on the plasma density in the Ogra-3 device. Zhil'tsov, V.A.; Kosarev, P.M.; Likhtenshtein, V.K.; Panov, D.A.; Chuyanov, V.Y.; Shcherbakov, A.G. (I. V. Kurchatov Institute of Atomic Energy, Moscow). **3**: No. 1, 20-25(Jan 1977).

An experimental study has been made of the factors limiting the plasma density in the Ogra-3. When a feedback system is used to suppress the flute instability, the density is limited by an instability near the ion gyrofrequency, rather than by flute waves, which are completely suppressed. The measured characteristics of the instabilities are reported, and experiments on their suppression are described.

1809 Turbulent plasma heating in the T-5M toroidal device. Gribkov, V.A.; Ivanov, M.I.; Kalinnikov, G.I.; Krokhin, O.N.; Kozlov, O.V.; Nikulin, V.Y.; Sklizkov, G.V. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). **3**: No. 1, 102-103(Jan 1977).

Experiments on the turbulent ohmic heating in the T-5M toroidal device were performed. The magnetic field reached 10 kOe while the maximum current achieved was 12 kA.(AIP)

1810 Experimental observation of enhanced plasma loss due to Ohmic heating currents. Alcock, M.W.; Ashby, D.E.T.F.; Cordey, J.G.; Edlington, T.; Fletcher, W.H.W.; Jones, E.M.; Riviere, A.C.; Start, D.F.H.; Sweetman, D.R. (UKAEA Research Group, Abingdon. Culham Lab.); Malmberg, J. (California Univ., San Diego (USA)). pp 305-320 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R (6 - 13 Oct 1976).

Experiments in the Culham Levitron have measured enhanced plasma loss rates when current is induced parallel to the magnetic field. There is good agreement between changes in loss rate and fluctuation amplitude and the enhancement is believed to be due to the presence of current-driven drift modes. Detailed measurements of the mode structure show radial widths which are narrow and insensitive to shear. This result disagrees with existing slab-model theories but is in closer agreement with recent finite geometry calculations. The shear, collisionality and u/vsub(e) are similar to those of many tokamak experiments. The confinement time increases with density, and comparison with empirical scaling laws for tokamaks shows an interesting level of agreement.

1811 Plasma experiments on staged theta pinch, implosion heating experiment and Scyllac feedback-sector experiment. Bartsch, R.R.; Buchenauer, C.J.; Cantrell, E.L. (Los Alamos Scientific Lab., N.Mex. (USA)) (and others). pp 193-200 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R (6 - 13 Oct 1976).

Results of the Los Alamos theta-pinch program in three areas of investigation are summarized: 1) In the Staged Theta Pinch, results are reported on the effects of magnetic field amplitude and time history of plasma formation. 2) In the Implosion Heating Experiment, density, internal-magnetic field and neutron measurements yield a consistent picture of the implosion which agrees with kinetic computations and with a simple dynamic model of the ions and magnetic piston. 3) In the Scyllac Feedback-Sector Experiment, the l=1, 0 equilibrium plasma parameters have been adjusted to accommodate the feedback stabilization system. With a uniform toroidal discharge tube the m=1 instability is feedback-stabilized in the vertical direction, and confinement in the toroidal direction is extended by feedback control. Results with a helical discharge tube are also reported.

1812 Progress toward relativistic electron beam heating of magnetically confined systems. Benford, J.; Bailey, V.; Young, T.S.T.; Dakin, D.; Ecker, B.; Putnam, S.; Di Capua, M.; Cooper, R. (Physics International Co., San Leandro, Calif. (USA)); Hammer, D.A.; Gerber, K. pp 543-554 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R. (6 - 13 Oct 1976).

Experimental and theoretical investigations of the feasibility of electron beam heating for fusion are reviewed. Progress at four United States laboratories on understanding the beam-plasma interaction and developing reactor schemes employing it are summarized.

1813 Heating of a helium plasma by a CO_2 laser beam. Byszewski, W.W.; Box, S.J.C.; John, P.K. (University of Western Ontario, London (Canada). Dept. of Physics). pp 627-633 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R. (6 - 13 Oct 1976).

The results of experimental studies of the interaction of a CO_2 laser beam with plasma produced in an electromagnetic shock tube are presented. A helium plasma of a temperature of 2eV and an electron density in the range of 10^{17} to $10^{18}cm^{-3}$ is produced in a T-type electromagnetic shock tube. A TEA type CO_2 laser with 180ns pulse width and 0.3J energy is used. Spectroscopic methods are used in the density and temperature measurements. The path of the laser beam through the plasma is observed directly by an image converter camera in conjunction with a narrow band interference filter. The interaction is investigated in two different configurations: with the laser beam perpendicular and parallel to the direction of propagation of the shock wave. In the first configuration, plasma heating is studied spectroscopically and in the second visually by examination of plasma expansion and laser beam refraction. The observed maximum increase in electron temperature due to the laser in the first configuration is 0.4eV and the estimated temperature increase in the second configuration is about 2eV. In the last case, the laser beam refraction is not significant. The highest possible increase in the diameter of the heated plasma is estimated to be one third of the initial value. The paper deals with the case where the absorption length of laser radiation in the plasma is smaller than or comparable to the plasma length. No confining magnetic field is applied here.

1814 Theory of plasma confinement in tokamaks of non-circular cross-section and optimization of the Doublet III design. Chu, M.S.; Dobrott, D.R.; Guest, G.E.; Helton, F.J.; Jensen, T.H.; Luxon, J.L.; Miller, R.L.; Ohkawa, T.; Rawls, J.M.; Wang, T.S. (General Atomic Co., San Diego, Calif. (USA)). pp 387-394 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R (6 - 13 Oct 1976).

The theory of plasma confinement in non-circular tokamaks has been developed and applied to resolve critical questions in the design of the Doublet III experiment. Equilibria are analysed in the ideal MHD theory using free-boundary numerical techniques and a wide range of models of the diffuse plasma pressure and current. The plasma cross-sectional shape is studied as the current profile and external shaping flux are varied. Arrays of field-shaping coils (F-coils) to produce the desired 3: 1 vertically elongated doublet are tested with this computational model. The gross stability of non-circular tokamaks has been studied extensively using variational techniques. Axisymmetric modes, expected to occur in vertically elongated plasma columns, are found to be stabilized if conducting walls are near enough to the plasma surface. Ideal and resistive criteria for the stability of localized interchange modes have been used to evaluate the maximum plasma pressure (and current) that can be stably confined in plasmas of varying cross-sectional shapes. Doublet- and dee-shaped tokamaks are stable at sufficiently high plasma pressures to suggest that interchange need not be the limiting phenomenon. In various configurations, optimized for maximum plasma pressure, the safety factor q appears to have the same significance for circular and non-circular discharges. A dynamical description of non-circular discharges has been developed by interleaving a one-dimensional, time-dependent transport computation with a two-dimensional, static MHD equilibrium calculation. Results of these studies and corresponding Doublet III design parameters are summarized.

1815 Energy amplification in tokamaks by fast-ion injection. Cordey, J.G.; Haas, F.A. (UKAEA Research Group, Abingdon. Culham Lab.). pp 423-434 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R. (6 - 13 Oct 1976).

The energy amplification factor Q and the ntau product are calculated for toroidal energy amplifiers with four different fast-ion configurations; counterstreaming deuterons and tritons (CIT mode); perpendicular injection; isotropic injection; Maxwellian ion distributions. The Q of the CIT configuration is approximately double that of any of the other configurations at low energies (approximately 60keV), but a high energies (approximately 200keV) the values of Q are of similar magnitude. A small density of thermal ions is found to reduce substantially the Q of all the systems. To study the equilibrium properties of these devices a set of one-fluid equations is derived from the Vlasov equations of each species. A high-β equilibrium is found for the CIT configuration where the pressure is anisotropic with p parallel much> p perpedicular. The addition of a toroidal flow is shown to have a small deleterious effect on the equilibrium-β limit.

1816 High-frequency heating and equilibrium plasmas in the Uragan-2 stellarator. Dikii, A.G.; Kalinichenko, S.S.; Kuznetsov, Y.K.; Kurilko, P.I.; Lysoivan, A.I.; Pashnev, V.K.; Tarasenko, V.F.; Suprunenko, V.A.; Tolok, V.T.; Shvets, O.M. (AN Ukrainskoj SSR, Kharkov. Fiziko-Tekhnicheskij Inst.). pp 129-142 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R (6 - 13 Oct 1976).

The high-density stellarator plasma in the range of strong magnetic fields ($H_0 > H_{0i}$) was subject to HF heating by means of a dielectrically unshielded exciting device located inside the vacuum chamber. The effect of current bypass was discovered in the exciting device caused by the plasma of an Ohmic discharge. Quasisteady currents were measured in the plasma under the conditions of HF heating. The influence of these currents was studied on the distortion and destruction of the magnetic surfaces.

1817 Investigation of plasma confinement in a device with a three-dimensional axis. Dremin, M.M.; Solntsev, A.M.; Stefanovskii, A.M. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). pp 169-177 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R (6 - 13 Oct 1976).

The results of investigating plasma behaviour in a closed trap with a three-dimensional axis resembling a four-arc figure-eight are presented. The existence of vacuum magnetic surfaces is confirmed by numerical calculations and experiments. The results of straightforward consideration of the diffusion coefficient in this system as a

function of the collision frequency are presented. The particle lifetime in a weakly ionized plasma produced by an electron beam (n approximately 10^9 to 10^{11} cm^{-3}; Tsub(e) approximately 10 eV) is in satisfactory agreement with the theoretical calculations. The energy lifetime in a Joule plasma (n approximately 10^{12} to 10^{13} cm^{-3}; Tsub(e sigma) approximately 30 to 100 eV) with small discharge currents (approximately <1 kA) is approximately equal to the value given by the empirical formula for tokamaks. As the plasma current increases, the variation in the plasma parameters observed does not contradict the picture of increasing plasma interaction with the walls due to displacement of the column.

1818 Plasma heating by an intense relativistic electron beam. Dymoke-Bradshaw, A.K.L.; Dangor, A.E.; Kilkenny, J.D. (Imperial Coll. of Science and Technology, London (UK). Dept. of Physics). pp 555-564 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R. (6 - 13 Oct 1976).

Experiments are reported on the heating of a hydrogen plasma by a relativistic electron beam with nu/γ approximately 2.4, maximum voltage 350keV, maximum current 50kA, diameter 2cm and duration 100ns. The beam is injected along a magnetic field of 2T into both neutral gas and preformed plasma. Experiments with neutral gas show that the heating depends on the beam pulse shape and angular scatter but that in all cases the primary heating mechanism is that due to return current dissipation. The maximum plasma energy observed is $3.3X10^{18}eVcm^{-3}$ for injection of a fast-rising cold beam into 100 mtorr hydrogen. Preliminary heating experiments in a preformed plasma show that there is both expansion of the plasma and probably a high-energy tail.

1819 Experiments on heating and flux-limited thermal conduction in a laser-heated plasma. Gray, D.R.; Kilkenny, J.D.; White, M.S.; Dangor, A.E. (Imperial Coll. of Science and Technology, London (UK)); Blythe, P.; Hull, D. (UKAEA Weapons Group, Aldermaston. Atomic Weapons Research Establishment). pp 613-625 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R. (6 - 13 Oct 1976).

Results on the CO_2 laser heating and cooling of a hydrogen Z-pinch with nsub(e) approximately $10^{17}cm^{-3}$ are presented. Experiments were performed with both a 20-MW gain-switched CO_2 laser and a 500-MW, 1.7nsCO_2 laser pulse. Spatial solution of the number density and temperature rise has been achieved by synchronized ruby laser scattering with a time resolution of 1.2ns. It is shown that results of a 20-MW experiment which were previously interpreted to give an approximately 40% classical thermal conductivity are explainable in terms of a heat flux limit approximately 10% The preliminary results with the 500-MW heating pulse indicate that a 10% flux limit gives too low a conduction. The backscattering instabilities are shown not to be important in the absorption process. Backscattering is seen only at a higher Z-pinch density than used in the heating experiment. The exponential growth of this backscattering is shown to agree with a coherent wave theory and to disagree with a random phase theory.

1820 Non-linear interaction of an ion flux with plasma. Ivanov, A.A.; Krasheninnikov, S.I.; Pistunovich, V.I.; Soboleva, T.K.; Yushmanov, P.N. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). pp 513-524 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R (6 - 13 Oct 1976).

The interaction with a plasma of an ion beam, formed during the charge exchange of injected neutral atoms, is discussed. Methods of analytical study by means of quasilinear equations as well as two-dimentional numerical modelling are used. It is shown that at a beam velocity usub(o)/csub(s) approximately $< 1/2$, the relaxation process may be described by using the theory of quasilinear relaxation of electron beams, at usub(o)/csub(s) approximately > 10; one can neglect the slowing down of the ion beam and consider only the angular spread. An analytical dependence of the spread angle on time was obtained. On the basis of the ion beam relaxation theory evolved, experiments on charge exchange of plasma fluxes on a gas target are analysed. It is shown that the anomalous scattering of the plasma flux observed in a series of experiments may be explained by the interaction of ions of the flux with ion-acoustic oscillations of the target plasma. Damping of ion-acoustic noise by the plasma electrons and ions leads to a limitation of the relaxation of the angular distribution function. The relationships obtained are in good agreement with the experimental results.

1821 Energy transfer of a relativistic electron beam to a plasma. Jurgens, B.; Hopman, H.J.; de Haan, P.; de Jagher, P.C.; Kistemaker, J. (Stichting voor Fundamenteel Onderzoek der Materie, Amsterdam (Netherlands). Instituut voor Atoom en Molecuulfysica). pp 527-533 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R (6 - 13 Oct 1976).

The energy loss of a relativistic electron beam and the accompanying plasma heating have been measured in an experiment injecting and electron beam of 500 keV, 0.5 kA and 20 ns pulse duration into a plasma of density between 10^{11} cm^{-3} and 10^{12} cm^{-3} confined in a magnetic mirror trap with 0.2T in the homogeneous middle section of 2 m length. The diamagnetic loop measurements show plasma perpendicular energies corresponding to heating efficiencies up to 10%. Results with an energy analyser show that the beam loses about 10% of its energy. Beam energy spectrum and loss as a function of time are shown. Energy losses and plasma electron heating agree within a factor two with theoretical calculations for energy transfer due to the beam excited instability at the electron plasma frequency.

1822 Absorption of CO_2 laser light by a dense high-temperature plasma. Peacock, N.J.; Forrest, M.J.; Morgan, P.D. (Euratom/UKAEA Fusion Association, Culham Lab., Abingdon, Oxfordshire, UK); Goldman, M.V.; Rudolph, T. (Colorado Univ., Boulder (USA)); Kuriki, K. (Tokyo Univ. (Japan)); Offenberger, A.A. (Alberta Univ., Edmonton (Canada)). pp 635-s648 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R. (6 - 13 Oct 1976).

The interaction between a pulsed CO_2 laser beam and the keV temperature plasma produced in a well diagnosed plasma focus device is investigated theoretically and experimentally. Absorption of the laser radiation is observed only during the compressed pinch phase of the discharge when the plasma frequency $\omega sub(pe) > \omega sub(CO_2)$. The absorption can only in part be accounted for by classical resistivity and resonance coupling of the pump beam with plasma waves. While the energy density of the pump radiation is much less than the kinetic energy density of the plasma, it is still sufficiently high, allowing for an Airy enhancement factor, to drive non-linear instabilities. Density fluctuations enhanced above their thermal level have been observed by forward scattering from a pulsed ruby laser beam. A WKB treatment of the electron-ion decay instability, which takes into account linear growth of waves $\omega sub(L) + \omega sub(i) = \omega sub(CO_2)$, and their convection in an inhomogeneous plasma, agrees well with the observed level of the electron waves.

1823 Effect of impurity radiation on tokamak equilibrium. Rebut, P.H.; Green, B.J. (JET Design Team, Culham Lab., Abingdon, Oxfordshire, United Kingdom). pp 3-16 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R. (6 - 13 Oct 1976).

The energy loss from a tokamak plasma due to the radiation from impurities is of great importance in the overall energy balance. Taking the temperature dependence of this loss for two impurities characteristic of those present in existing tokamak plasmas, the condition for radial power balance is derived. For the impurities considered (oxygen and iron) it is found that the radiation losses are concentrated in a thin outer layer of the plasma and the equilibrium condition places an upper limit on the plasma paraticle number density in this region. This limiting density scales with mean current density in the same manner as is experimentally observed for the peak number density of tokamak plasmas. The stability of such equilibria is also discussed.

1824 Numerical and analytical results for anomalous diffusion in tokamaks due to dissipative trapped-ion instability. Saison, R.; Wimmel, H.K. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). pp 481-487 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R (6 - 13 Oct 1976).

The trapped-fluid equations of Kadomtsev and Pogutse (K.P.) are solved numerically as an initial-value problem with due observation of the appropriate boundary conditions, which are derived. Numerical results are given for the value of the anomalous diffusion coefficient D at late times and for its dependence on the magnetic field, temperature, density, etc. Examples of the time development D(t) are also given. The main result is: the numerical values of D

are, in general, larger than according to K.P.; and the scaling of D with B, T, Nsup(p), etc., differs from K.P.'s, but also varies considerably with the parameter values involved. In addition, several analytical results are presented, e.g. special non-linear solutions, invariance properties, and from dimensional analysis a general "scaling law" for D (B, T, Nsup(p), etc.) is obtained. Some of these analytical results have been successfully used for testing the numerical programme.

1825 Injection of a relativistic electron beam into an inhomogeneous magnetized plasma. Sunka, P.; Jungwirth, K.; Kovac, I.; Piffl, V.; Stoeckel, J.; Ullschmied, J. (Ceskoslovenska Akademie Ved, Prague. Ustav Fyziky Plazmatu). pp 535-541 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R (6 - 13 Oct 1976).

The interaction of a high-power relativistic electron beam (REB) with an inhomogeneous magnetized plasma has been investigated. The REB (400 keV, 10 kA, 70 ns) is injected along the magnetic field into a plasmoid ($n <= 5x10^{13}$ cm^{-3}), which is generated near the anode of the high-voltage diode and moves in the same direction as the REB. By varying the time delay tsub(D) between the plasma and beam injections, it is possible to vary both the length and the longitudinal density profile of the plasma column into which the beam is injected. Propagation of the REB through the system and plasma heating are examined for various tsub(D). The maximum heating (diamagnetic signal corresponding to nEsub(perpendicular)S = $5x10^{17}$ eVcm^{-1}) is observed if the plasma column is not in contact with the collector plate. At least 10% of the injected beam energy is transferred into the plasma. Energetic charge-exchange neutrals escaping radially from the plasma indicate the presence of ions with energies up to 30 keV. Formation of a virtual cathode and partial reflection of the beam electrons are observed. A one-dimensional theoretical model of a system with the virtual cathode has been investigated. The feasibility of the accumulation of relativistic electrons within the plasma column and the acceleration of the ions at the plasma-vacuum boundary are demonstrated.

1826 Plasma focus heating by a TEA CO_2 laser. Tanimoto, M.; Koyama, K.; Matsumoto, Y.; Sugiura, M. (Electrotechnical Lab., Tanashi, Tokyo (Japan). Tanashi Branch). pp 605-612 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R. (6 - 13 Oct 1976).

TEA CO_2 laser interaction with high-density and high-temperature plasma produced by a focus device is studied experimentally. With a 10.6-μm laser light of flux density 10^{12}Wcm^{-2} on plasma of critical density $>10^{19}$cm^{-3} and thermonuclear temperature approximately $>$ 1keV, parametric decay instability is detected from an optical multichannel spectrum analysis. At about the maximum pinch of the focus, very small reflection and transmission of the incident laser pulse indicate an efficient laser absorption. An increase in X-ray radiation and very intense delayed laser light emission are also observed.

1827 Plasma plugging by radio-frequency field in a resonant cavity. Akiyama, H.; Takeda, S. (Nagoya Univ. (Japan). Faculty of Engineering). **41**: No. 3, 1036-1040(Sep 1976).

The plugging is experimentally studied in the steady state plasma with flow by using a cavity. The increase of the density is observed in the upstream side of the cavity, whereas the decrease of the density and the increase of the electron temperature are observed in the downstream side. The density exponentially decreases with the electric field as expected from the theory for the electric field lower than a certain value. However, the density decrease becomes linearly proportional to the electric field, when the amplitude of the high frequency is self modulated.

1828 Ion heating caused by coherent ion acoustic waves. Kawai, Y.; Tanaka, M. (Kyushu Univ., Fukuoka (Japan). Research Inst. for Applied Mechanics). **41**: No. 3, 1079-1080(Sep 1976).

Published in summary form only.

1829 Heating of plasma focus by TEA CO_2 laser. Kitagawa, Y.; Thein, A.; Setoyama, E.; Yamabe, C.; Yokoyama, M. (Osaka Univ. (Japan)). **41**: No. 3, 1081-1082(Sep 1976).

Published in summary form only.

1830 Plasma heating in the TP-M device by the injection of a spiraling electron beam. Yatsui, K.; Yatsuzuka, M.; Aihara, S. (Nagoya Univ. (Japan). Inst. of Plasma Physics). **41**: No. 3, 1083-1084(Sep 1976).

Published in summary form only.

1831 Plasma heating by ion-cyclotron parametric instability in a modulated electron-beam-plasma system. Yatsui, K.; Shimada, M.; Yokoyama, M. (Osaka Univ., Toyonaka (Japan). Faculty of Engineering Science). **41**: No. 3, 1085-1086(Sep 1976).

Published in summary form only.

1832 Two-energy-component plasma in a mirror-torus hybrid. Yamagishi, T.; Akimune, H. (Osaka Univ., Suita (Japan). Faculty of Engineering). **13**: No. 8, 459-461(Aug 1976).

Published in summary form only.

PLASMA DIAGNOSTICS

1833 (CONF-770725—1) **Electron number density measurement by ruby laser interferometry.** Chu, T.K.; Johnson, L.C.; Schuss, J.J. 1977. Contract EY-76-C-02-3073. 6p. Dep. NTIS, PC A02/MF A01.

From 11. international symposium on shock tubes and waves; Seattle, Washington, USA (11 Jul 1977).

A pulsed ruby laser beam with 3 nsec full width at half magnitude is used to obtain space- and time-resolved, two-dimensional interferometric measurements of electron number density in CO_2-laser produced plasma in hydrogen near the focal spot. The focal plane of the CO_2 laser is arranged to be at the exit of a free-expansion jet, with the beam incident from the vacuum side. Several nanoseconds after breakdown, a shock wave is formed, propagating transverse to the incident laser beam direction. Behind the transverse propagating shock is an on axis density minimum, which results in laser-beam self trapping. During the initial pulse duration of the CO_2 laser, the radial boundary of the plasma column increases linearly in time.

1834 (COO—4000-1) **Study of x-ray imaging systems for the 10 to 100 keV energy range. Final report, June 15, 1976—March 12, 1977.** Silk, J.K.; Burstein, P. Mar 1977. Contract EY-76-C-02-4000. 91p. (ASE—4104). Dep. NTIS, PC A05/MF A01.

This report describes an investigation of the imaging of X-rays with energies greater than 10 keV for electron beam fusion diagnostics. Two approaches were considered. The first was an adaptation of the grazing-incidence imaging techniques used for softer X-rays (less than 2 keV). The second method employed an array of Bragg crystals to focus the X-rays.

1835 Laser fusion ion temperatures determined by neutron time-of-flight techniques. Lerche, R.A.; Coleman, L.W.; Houghton, J.W.; Speck, D.R.; Storm, E.K. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). **31**: No. 10, 645-647(15 Nov 1977).

Measurements have been made of the energy spectrum of neutrons emitted as a result of laser compression of D-T-filled glass microshells using a time-of-flight spectrometer. From the width of unfolded energy spectra, plasma ion temperatures of approximately 6 keV have been determined for 90-μm-diam targets irradiated with 2 TW of 1.06-μm light. The measured mean neutron energy of 14.00 +- 0.10 MeV agrees with the expected value of 14.05 MeV.

1836 Expansion velocities of laser-produced plasmas determined from extreme ultraviolet spectral line profiles. Feldman, U.; Doschek, G.A.; Behring, W.E.; Cohen, L. (E. O. Hulburt Center for Space Research, Naval Research Laboratory, Washington, D. C. 20375). **31**: No. 9, 571-573(1 Nov 1977).

The expansion of laser-produced plasma is determined from the shapes of spectral lines of highly ionized iron emitted in the extreme ultraviolet. The plasmas were produced by focusing the pulse from a Nd : glass laser onto solid planar targets, and spectra were recorded with a high-resolution grazing incidence spectrograph. From the Doppler broadening of lines of Fe XX and Fe XXI, expansion velocities of $\sim$830 km s^{-1} were determined. The relative time-averaged ion abundances of Fe XVIII, Fe XIX, Fe XX, and Fe XXI are estimated for three different spectra. The abundances do not differ by more than a factor of 4 for any of the spectra.

1837 X-ray emission characteristics of plasmas created by a high-intensity CO_2 laser. Enright, G.D.; Burnett, N.H.; Richardson, M.C. (National Research Council of Canada, Division of Physics, Ottawa, K1A 0R6, Canada). **31**: No. 8, 494-496(15 Oct 1977).

The spectrum of the x-ray continuum and line emission emanating from Al, Mg, and (CH_2)/sub n/ plasmas created with a nanosecond CO_2 laser pulse has been investigated at irradiance levels up to 2 x 10^{14} W/cm^2.

1838 Laser-target retropulse isolation using an aperture in vacuum. Benjamin, R.F.; Henderson, D.B.; Mitchell, K.B.; Stroscio, M.A.; Thomas, J. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). **31**: No. 8, 511-512(15 Oct 1977).

The plasma created near an aperture in vacuum is found to be an effective retropulse isolator for CO_2 laser light. The plasma created by a subjoule CO_2 beam remains overdense at least 50 ns after the CO_2 pulse.

1839 Spectroscopic study on the evaporation of aluminum as irradiated by a long-pulse Nd laser. Wei, P.S.P. (Boeing Aerospace Company, Seattle, Washington 98124). **48**: No. 10, 4196-4201(Oct 1977).

The plasma plume produced by a focused Nd laser beam (1.06 μm, 43 J, 1.2 msec) on an aluminum plate in air at power densities up to 3 x 10^7 W/cm^2 has been studied by the spectroscopic technique. The average speed of the luminous vapor jet is measured to be 8 x 10^3 cm/sec by the time-of-flight method. The emission spectrum, which consists mainly of Al and AlO, is similar to that from an electric arc. The temperature of the plasma is estimated to be < or =1 eV fom a theoretical analysis of the equilibrium composition of the A1-O system in the gas phase. Of particular interest is the detection of optically forbidden transitions from the np (^{2}P) and nf (^{2}F) states to the 3p (^{2}P) ground state of Al/sub I/ due to the instantaneously high density and electric field. From the Stark shift of the self-reversed 4d lines, the ion density is estimated as 9 x 10^{17}/cm^3. These results suggest that laser evaporation may be a novel source for studying atomic and molecular spectra at high density.

1840 Experimental study of the influence of surface-potential variations on the measurement of the electron temperature of a plasma by an electrostatic probe. Bujor, M. (Centre de Recherches en Physique de l'Environment Terrestre et Planetaire, La Source, 45045 Orleans Cedex, France). **48**: No. 10, 4202-4209(Oct 1977).

The quantitative influence of controlled spatial variations of the surface potential of an electrostatic probe on the measurement of the electron temperature has been studied experimentally using an electrostatic probe with an interdigital structure. By statistical treatment of a large number of measurements in an on-line computer, it was possible to detect changes in the apparent electron temperature of as little as 2%. Such changes occurred when potentials of the order of the electron thermal energy were applied to the surface of the probe on spatial scales of the order of the Debye length in the plasma. For larger potential variations, the influence on the apparent temperature was very important, regardless of the spatial scale.

1841 Use of a new type of plasma-ion analyzer to determine the hydrogen content of metals. Daly, N.R.; Powell, R.E. (Atomic Weapons Research Establishment, Aldermaston, Reading RG7 4PR, England). **48**: No. 10, 1336-1339(Oct 1977).

A pulsed laser has been used to vaporize and ionize very small areas on the surface of materials that contain hydrogen. A thin foil scintillation detector has been used to examine the plasma that expands away from the interaction region. This device has high sensitivity for detecting hydrogen ions and very low sensitivity for heavy mass ions. Its use to determine hydrogen concentrations in materials at low level has been examined. It can also be used to determine energy distributions for hydrogen ions from mixed ion plasmas by the time-of-flight method.

1842 Determination of electron energy distribution in a plasma. Chakravarti, P.K.; Gupta, S.N.S. (Saha Institute of Nuclear Physics, Calcutta—700 009, India). **48**: No. 10, 1344-1349(Oct 1977).

A simple method of direct display of electron energy distribution in a gaseous plasma is presented. The apparatus is an analog computer used on line with a Langmuir probe. The new features of this work are (1) an analysis of the time response of a filter input differentiating operational amplifier, (2) a procedure for noise eliminating differentiation that is also capable of taking account of the higher derivatives of the input signal, and (3) a simple determination of the plasma potential with a phase comparator. The method is being used in the analysis of electron energies in a positive column plasma. The results so far found show that the distribution has a single peak sharper than the Maxwellian at pressures of about 0.1 Torr and it changes into a two-peak distribution at lower pressures (~0.01 Torr). The second peak also found in similar studies by other investigators (Alexeff and Howell, Rezacova et al.) is possibly due to the presence of accelerated electrons from the hot cathode of the discharge.

1843 Dynamic screening effects in plasma line broadening. Hussey, T.W.; Dufty, J.W.; Hooper, C.F. Jr. (Air Force Weapons Laboratory, Kirtland Air Force Base, New Mexico 87117). **16**: No. 3, 1248-1257(Sep 1977).

The results of a kinetic theory of spectral-line broadening are applied to the calculation of Stark broadening for the Lyman-α line in the classical-path approximation. In the small-plasma-parameter limit, the width and shift operator reduces to an average binary electron-atom collision operator with screened interactions and dynamic correlations. The effects of screening, particularly the variation with frequency, are indicated for a simplified model and compared with the corresponding model without screening but with an impact-parameter cutoff in the collision integral. Comparison with the dynamically screened second-order (Born approximation) collision integral is also given.

1844 New elementary experiments in plasma physics. Alexeff, I.; Pytlinski, J.T.; Oleson, N.L. (University of Tennessee, Knoxville, Tennessee 37916). **45**: No. 9, 860-866(Sep 1977).

Several plasma physics experiments especially suitable for an undergraduate physics laboratory are described. The experiments can be set up using commercially available gas tubes and standard electronic equipment available in most university or college laboratories. The simplicity of the equipment involved and its low cost are features of these experiments. An introductory plasma physics course or a modern physics course gives adequate theoretical background to perform the experiments.

1845 X-ray shadowgraphing in laser-produced plasma experiments. vanHulsteyn, D.B.; Benjamin, R.F. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). **1**: No. 2, 76-78(Aug 1977).

We discuss a design for an x-ray framing camera. Shadowgraphing experiments using a laser-generated x-ray source demonstrate that 5-μm spatial resolution can be obtained for this camera with less than 7 J of laser energy to produce the x-ray source.

1846 Measurement of the noise temperature of a plasma of combustion products, using a contactless capacitive converter. Ivashchenko, Y.S.; Korobchenko, Y.G.; Bondarenko, T.S. (Siberian Institute of Technology, Krasnoyarsk). **14**: No. 6, 1128-1132(May 1977).

This article discusses questions of the use of contactless capacitive converters for the noise thermometry of a plasma of combustion products. It gives the results of measurements of the noise temperature in an acetylene flame at atmospheric pressure.

1847 Direct measurement of the barycentric velocity of a plasma by time of flight. Gaucherel, P.; Rowe, B. (Centre National de la Recherche Scientifique, 92 - Meudon-Bellevue (France)). **23**: No. 3, 227-235(Mar 1977).

A simple apparatus is described which, when coupled to a mass spectrometer, enables measurement of the barycentric velocity of a plasma by time of flight. The results are discussed from experimental and theoretical standpoints and the absence of perturbation is proved.

1848 Method for measuring the spatial distribution of soft x-ray emission in the T-4 tokamak. Vershkov, V.A.; Mirnov, S.V. (I. V. Kurchatov Institute of Atomic Energy, Moscow). **3**: No. 2, 109-110(Mar 1977).

A rotatng sollers collimator was used to study the electron temperatures of a T-4 tokamak. A spatial resolution of 3.5 cm was achieved for a plasma radius of 17 cm.(AIP)

1849 Plasma diagnostics by means of shortwave thermal radiation. Tishchenko, E.A.; Vainshtein, L.A. (Physical Laboratory, Academy of Sciences of the USSR, Moscow). **3**: No. 1, 71-77(Jan 1977).

A solution is found for the problem of detecting the thermal radiation of a plasma by a directional antenna in the frequency range for which the scale dimensions of the plasma are much longer than the wavelength. No restrictions are imposed on the wave refraction or integral damping in the plasma. Measurements of this type make it possible to calculate the product of the plasma conductivity and temperature as a function of the cylindrical coordinate r if the wave damping in the plasma is negligible. It is necessary for this purpose to solve two linear integral equations of the first kind: a convolution equation and an Abel equation. It is also necessary to calibrate the receiving antenna; this again involves the solution of a convolution equation.

1850 Ion density measurements with a hollow probe. Hayashi, S. (Keio Univ., Yokohama (Japan). Faculty of Engineering). **15**: No. 12, 2409-2411(Dec 1976).

In order to measure the number density of charged particles in a high speed flow of slightly ionized argon, a hollow electric collector probe was fabricated. It was found that the application of a strong magnetic field was useful to collect almost all the charged particles entering the probe with a large electric field. The probe was used to obtain ion density profiles behind shock waves with a large electric field. The probe was used to obtain ion density profiles behind shock waves with Mach numbers from 6.0 to 8.5 with the initial pressures of 2.0 and 4.0 mmHg. The ion densities measured were in the range from 10^{11} to 10^{13} cm^{-3}. The experimental results were compared with the electron densities measured by microwave techniques. The equilibrium ion densities were in good agreement with those measured by the microwave probe.

1851 Electron density measurement of a tokamak plasma by an HCN-laser interferometer. Nishizawa, A.; Masuzaki, M.; Mohri, A. (Nagoya Univ. (Japan). Inst. of Plasma Physics). **15**: No. 9, 1753-1760(Sep 1976).

An HCN-laser interferometer has been constructed for the measurement of the electron density of plasmas. The output power of the HCN laser has been stabilized to be suitable for long-term operation. The interferometer is of Michelson-type with a concave mirror as the reflecting mirror so as to reduce the refractive effect due to plasmas. The mean electron density of SPAC-II tokamak plasma ($3 - 7.5 \times 10^{13} cm^{-3}$) was measured by this interferometer. The signal-to-noise ratio was 20, which was mainly caused by the fluctuation of the laser output power. Changes of the phase shift corresponding to voltage spikes in the one-turn-loop voltage signal were also observed.

PLASMA KINETICS - GENERAL

REFER ALSO TO CITATION(S) 1616

1852 (AD-A—041545) **Revised and enlarged collection of plasma physics formulas and data. Final report.** Book, D.L. May 1977. 103p. (NRL-MR—3332). NTIS PC A06/MF A01.

This report is intended to serve as a kind of users' manual for the NRL Plasma Formulary, supplying explanations, worked examples and references, for which space in the pocket version was insufficient. A certain amount of supplementary material has been included.

1853 (CONF-770721—1) **Atomic reactions in very high temperature plasmas.** Crandall, D.H. 1977. Contract W-7405-ENG-26. 8p. Dep. NTIS, PC A02/MF A03.

From 3. international symposium on plasma chemistry; Limoges, France (13 Jul 1977).

Some examples of atomic-related research to the fusion energy program are described. An overall spectrum of radiation from ORMAK in the 40 to 70 A range is shown. Power losses through impurities are discussed. (MOW)

1854 **Outlook for the use of the beam—plasma discharge in plasma chemistry.** Ivanov, A.A.; Soboleva, T.K.; Yushmanov, P.N. (I. V. Kurchatov Institute of Atomic Energy, Moscow). 3: No. 1, 87-93(Jan 1977).

The possible use of the beam—plasma discharge in plasma chemistry is discussed. It is shown that an electron beam can transfer energy efficiently to plasma electrons and that energy can be pumped to internal degrees of freedom of the reactants without exciting translational degrees of freedom.

1855 **Emission coefficient of the continuum in an argon and nitrogen plasma at high temperatures.** Erhardt, K.; Meyer, I.; Stritzke, P. (Hamburg Univ. (Germany, F.R.). Inst. fuer Angewandte Physik). 32: No. 1, 21-27(Jan 1977).

8 figs.; 20 refs.

The continuum emission of an argon- and nitrogen plasma developed in an electrical discharge has been investigated in the wavelength range from 3,000 A to 6,700 A. For this purpose the time- und radial dependent plasma parameters, such as temperature and the total pressure have been determined in the high conducting stage of the spark by measuring several line intensities. The continuum coefficient was calculated from these data according to the Kramers-Unsoeld theory. The comparison of the theoretical and the measured values shows deviations which are discussed.

1856 **Initial stage of discharge development in tokamaks.** Abramov, V.A.; Vikhrev, V.V.; Pogutse, O.P. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). pp 237-244 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R. (6 - 13 Oct 1976).

The results of analysis and numerical calculations of equations describing discharge development in toroidal systems with a strong longitudinal field are presented. The results of numerical integration of the following system of equations describing gas breakdown in tokamaks are given: 1) the equation of continuity for the electrons with allowance for ionization and diffusion, 2) the equation of continuity for the electrons with allowance for ionization and diffusion, 2) the equation for the average electron energy (temperature) with allowance for thermal conductivity, ionization and radiation, 3) the electrodynamic equation describing the skin effect for the electric field. In solving the equations, particular attention was paid to clarifying the dependence of the time required for total ionization of the gas on the plasma parameters. It is shown, in particular, that the curve giving the ionization time as a function of the electric field has a minimum, i.e. optimum fields exist where a minimum number of volts per second is expended on breakdown. It is shown that a steep ionization front may be formed under certain conditions and this may substantially retard the discharge development in devices with fairly large cross-sections. Graphs showing the volts per second expended on breakdown as a function of the neutral gas density and the chamber radius are plotted and profiles of the electron temperature, the current density and the electric field at various points in time are also given.(author).

1857 **Derivation of plasma displacement in a tokamak from magnetic probe signals.** Aikawa, H.; Ogata, A.; Suzuki, Y. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). 15: No. 10, 2031-2032(Oct 1976).

Published in summary form only.

PLASMA KINETICS - EXPERIMENTAL

1858 **Stable thermonuclear reaction from Tokamak 10.** 31: No. 3, 224-225(Mar 1977). (In German).

Short communication only. Translated from English. Also published in Electr. Times (no. 4367) Feb 1976 p. 4.

1859 **Plasma decay in O_2—N_2 and CO—N_2 mixtures.** Vasil'eva, A.N.; Grishina, I.A.; Kovalev, A.S.; Ktitorov, V.I.; Loginov, N.A.; Rakhimov, A.T. (Scientific-Research Institute of Nuclear Physics, M. V. Lomonosov Moscow State University). 3: No. 2, 226-230(Mar 1977).

The decay of plasma in mixtures containing oxygen and carbon monoxide impurities is studied in a constant electric field and without an electric field. In all cases the plasma decay is ascribable to recombination. The effective recombination constants are measured as functions of the composition and pressure of the gas mixture, the applied field, and the energy of the ionizing pulse. The experimental results are compared with theory.

1860 **New regime in the T-4 tokamak.** Berlizov, A.B.; Lysenko, S.E.; Notkin, G.E.; Shcheglov, D.A. (I. V. Kurchatov Institute of Atomic Energy, Moscow). 3: No. 1, 1-2(Jan 1977).

The distributions of the electron temperature T/sub e/ and the electron density n/sub e/ in the T-4 tokamak have been measured for the case of a longitudinal magnetic field of B/sub z/ = 37 kG and a current of I = 110 kA, which correspond to a safety factor of q = 5.4 at the limiter. The n/sub e/ and T/sub e/ distributions are flatter than in regimes studied previously.

1861 **Holographic-interference study of the plasma density distribution in a current sheet.** Dreiden, G.V.; Kirii, N.P.; Markov, V.S.; Mirzabekov, A.M.; Ostrovskaya, G.V.; Frank, A.G.; Khodzhaev, A.Z.; Shedova, E.N. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). 3: No. 1, 26-31(Jan 1977).

The method of holographic interferometry has been used to study the dynamics of the plasma density distribution in various stages of the formation of a current sheet for various initial conditions. It is found that essentially all the plasma is concentrated in a plane sheet. Under certain conditions, pronounced inhomogeneities appear in the electron density over the width of the sheet. These conditions are determined.

1862 **dc analog of microwave-discharge plasma.** Ivanov, Y.A.; Lebedev, Y.A.; Polak, L.S. (A. V. Topchiev Institute of Petrochemical Synthesis, Academy of Sciences of the USSR). 3: No. 1, 84-87(Jan 1977).

The relationship between the electron energy distributions in the plasma of a dc glow discharge and in a microwave discharge in nitrogen has been studied experimentally. These distributions were measured with a Langmuir probe. The average electron energies (epsilon-bar) were approximately the same in the two cases. The measurements in the microwave plasma were carried out at a microwave power of 1—2.5 W/cm^3 at pressures of 1, 2, and 5 torr. The values of epsilon-bar at these pressures were 2.4, 2.0, and 1.7 eV, respectively, independent of the microwave power. In all the experiments in the microwave plasma the electron density was above the cutoff value. The electron energy distribution in the microwave plasma was approximately Maxwellian at energies up to 8 eV, while that in the dc discharge approached a Maxwellian distribution as the discharge current was raised. There were more electrons at high energies in the microwave plasma than in a Maxwellian distribution; the difference reached an order of magnitude at $\epsilon > 15$ eV. It is concluded that the electron energy distributions are approximately the same up to ~3epsilon-bar in the two types of discharges for a given specific input power, for a given discharge geometry, and for a given pressure. The difference at high electron energies is due to the particular way in which the electrons draw power from the microwave field.

1863 **Unified electron temperature characteristics in positive columns with including the ionization of metastable atoms.** Dote, T.; Ichikawa, Y. (Institute of Physical and Chemical Research, Wako, Saitama (Japan)). 41: No. 4, 1441-1442(Oct 1976).

Published in summary form only.

PLASMA KINETICS - THEORETICAL

1864 (AD-A—040090) **Two-dimensional fluid simulation of relativistic electron beam-high z target interactions. Interim report.** Colombant, D.G.; Mosher, D. May 1977. 21p. (NRL-MR—3496). NTIS PC A02/MF A01.

A two-dimensional r-z fluid code has been developed to study the interaction between a relativistic electron beam and an anode plasma. A self-consistent treatment of the electromagnetic fields has been included. Radial pinching of the beam is observed when its self-field resistively diffuses into the plasma. (Author)

1865 (LA-UR—77-1050) **Finite-gyroradius effects in screw pinches.** Lewis, H.R. 1977. Contract W-7405-ENG-36. 4p. (CONF-770906—3). Dep. NTIS, PC A02/MF A01.

From 8. European conference on controlled fusion and plasma physics; Prague, Czechoslovakia (19 Sep 1977).

The effects of finite ion gyroradius on the behavior of screw pinches are being studied numerically and analytically in the context of the Vlasov-fluid model.

1866 (ORNL/TM—5952) **Extensions of guiding center motion to higher order.** Northrop, T.G.; Rome, J.A. Jul 1977. Contract W-7405-ENG-26. 27p. Dep. NTIS, PC A03/MF A01.

In a static magnetic field, some well-known guiding center equations maintain their form when extended to next order in gyroradius. In these cases, it is only necessary to include the next order term in the magnetic moment series. The differential equation for guiding center motion which describes both the parallel and perpendicular velocities correctly through first order in gyroradius is given. The question of how to define the guiding center position through second order arises and is discussed, and second order drifts are derived for one usual definition. The toroidal canonical angular momentum, P/sub phi/, of the guiding center in an axisymmetric field is shown to be conserved using the guiding center velocity correct through first order. When second order motion is included, P/sub phi/ is no longer a constant. The above extensions of guiding center theory help to resolve the different tokamak orbits obtained either by using the guiding center equations of motion or by using conservation of P/sub phi/.

1867 (PPPL—1346) **Boltzmann equation integration in thermionic converter conditions. Part II. Terms in Boltzmann equation.** Stoenescu, M.L. Jun 1977. Contract EY-76-S-02-2798. 60p. Dep. NTIS, PC A04/MF A01.

The terms in Boltzmann kinetic equation corresponding to elastic short range collisions, inelastic excitational collisions, coulomb interactions and electric field acceleration are evaluated numerically for a standard distribution function minimizing the computational volume by expressing the terms as linear combinations with recalculable coefficients, of the distribution function and its derivatives. The present forms are suitable for spatial distribution calculations.

1868 (PPPL—1352) **Steady state radiative cooling rates for low-density high-temperature plasmas.** Post, D.E.; Jensen, R.V.; Tarter, C.B.; Grasberger, W.H.; Lokke, W.A. Jul 1977. Contract EY-76-C-02-3073;W-7405-ENG-48. 90p. Dep. NTIS, PC A05/MF A01.

Steady-state radiative cooling rates, average charge states [Z], and mean square charge states [Z^2] for 47 elements with atomic number Z ranging from 2 to 92 have been calculated for low-density (n/sub e/ $< 10^{16}$ electrons/cm^3), high-temperature (T = 0.002 $\rightarrow$ 100 keV) plasmas. The 47 elements spanning the periodic table include many materials of interest to controlled thermonuclear fusion research. The results for the radiation rates and charge states are presented graphically versus plasma temperature and in the form of least squares polynomial fits.

1869 **High-β tokamaks.** Sykes, A.; Wesson, J.A.; Cox, S.J. (EURATOM/United Kingdom Atomic Energy Authority Fusion Association, Culham Laboratory, Abingdon, Oxon, United Kingdom). **39**: No. 12, 757-760(19 Sep 1977).

A model allowing the calculation of very high-β tokamak equilibria with choice of β, β/sub p/, and q_0 is described. One of these equilibria having $\beta = 12\%$ has been shown to be stable to low-n internal modes.

1870 **Electron velocity distribution in a weakly ionized hf plasma.** Vashukov, S.I.; Marusin, V.V. (Institute of Physicochemical Foundations of Raw Minerals, Siberian Branch, Academy of Sciences of the USSR). **14**: No. 6, 1045-1053(May 1977).

The balance relationships and the form of the electron-distribution function in a weakly ionized hf plasma are analyzed for the case $\omega \sim \delta\nu$. Approximate expressions are obtained for the distribution function in the "thermal" and high-energy regions, where $\nu \sim v/$ sup k/ and δ=const. The difference between the time-averaged ionization frequency and the usual expression obtained by means of an effective field is shown.

1871 **Scaling method for obtaining kinetic equations from the BBGKY hierarchy.** Morita, T.; Mori, H.; Tokuyama, M. (Kyushu Univ., Fukuoka (Japan). Dept. of Physics). **61**: No. 1, 6-8(4 Apr 1977).

Kinetic equations for the one-particle distribution function of dilute gases and plasmas and evolution equations for the variance of their fluctuations are obtained from the BBGKY hierarchy equations by using Mori's scaling method in an extended form.

1872 **Effect of emitter-ion dynamics on the line core of Lyman-α.** Voslamber, D. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). **61**: No. 1, 27-29(4 Apr 1977).

An adiabatic treatment of emitter-ion dynamics for the central component of the Stark-broadened Lyman-α line of hydrogen leads to line-shapes significantly larger than those obtained with the quasi-static theory.

1873 **Shear viscosity of a strongly coupled one-component plasma.** Wallenborn, J.; Baus, M. (Brussels Univ. (Belgium)). **61**: No. 1, 35-36(4 Apr 1977).

It is shown on the basis of a microscopic theory that the shear viscosity of a one-component plasma exhibits a minimum as a function of temperature.

1874 **Saha's ionization equation for high Z elements.** Godwal, B.K.; Sikka, S.K. (Bhabha Atomic Research Centre, Bombay (India). Neutron Physics Section). **8**: No. 3, 217-222(Mar 1977). 10 refs.

Saha's ionization equation has been solved for high Z elements with the aim of providing input for opacity calculations. Results are presented for two elements, tungsten and uranium. The ionization potentials have been evaluated using the simple Bhor's formula with suitable effective charges for ions. The reliability of the free electron density, ion concentrations, etc., obtained from the Saha's equation solutions has been checked by comparing the P and E computed from them with those given by the Thomas-Fermi-Dirac equation of state. The agreement between the two is good from temperatures above 0.2 keV.

1875 **Spreading of a pronounced inhomogeneity in the presence of an unbounded weakly ionized background plasma in a magnetic field.** Rozhanskii, V.A.; Tsendin, L.D. (M. I. Kalinin Leningrad Polytechnical Institute). **3**: No. 2, 217-220(Mar 1977).

The spreading of a pronounced inhomogeneity $\delta n > n$ in the presence of an unbounded, homogeneous, weakly ionized background plasma in a magnetic field is studied. It is shown that the mechanism involving short-circuiting through the background plasma, which leads to a spreading of the density perturbation with unipolar electron and ion diffusion coefficients, is efficient even for extremely pronounced inhomogeneities. Only when extremely depleted regions appear in the background plasma, in which the density is much lower than n_0 is there a transition to ambipolar diffusion. In this case the scale lengths of the inhomogeneity are governed by the smallest values of the diffusion coefficients in the corresponding directions, and the plasma density at the maximum should be much larger than n_0.

1876 **Numerical simulation of internal-mode relaxation oscillations in a tokamak.** Dnestrovskii, Y.N.; Lysenko, S.E.; Smith, R. (I. V. Kurchatov Institute of Atomic Energy, Moscow). **3**: No. 1, 9-13(Jan 1977).

The internal-mode relaxation oscillations in a tokamak are simulated numerically. The slow stage of the oscillations is described by the system consisting of the energy balance equation and the current diffusion equation. The equations which follow from the MHD theory for the reconnection of the magnetic surfaces are used for the stage of the rapid disruption. The calculated values of the oscillation period, the temperature change, and the time in which the oscillations occur turn out to be approximately those measured in the T-4 tokamak. Comparison with experiment leads to a refinement in the dependence of the electron thermal conductivity on the plasma radius.

1877 **Collisionless hydrodynamics of z-pinch with finite ion Larmor radius and the interchange instability.** Trubnikov, B.A.; Zhdanov, S.K. (I. V. Kurchatov Institute of Atomic Energy, Moscow). **3**: No. 1, 45-50(Jan 1977).

The correct collisionless MHD approximation for the plasma is shown to be that of anisotropic hydrodynamics with a magnetic viscosity, with the finite ion Larmor radius being taken into account. These equations furnish a theoretical explanation for the constriction ("sausage") wavelength observed experimentally in the plasma channel of a straight discharge (Z pinch) {S. M. Osovets, E. I. Pavlov, and V. I. Sinitsyn, Zh. Eksp. Teor. Fiz. 64, 1228 (1973) [Sov. Phys. JETP 37, 625 (1973) }.

1878 **Relaxation of ion beam moving across a magnetic field in a plasma.** Aburdzhaniya, K.D.; Lominadze, D.G. (Institute of Applied Mathematics, Tbilisi State University). **3**: No. 1, 56-60(Jan 1977).

The nonlinear stage of the instabilities which occur in the interaction of an originally monoenergetic ion beam with a plasma in a magnetic field is analyzed. The energy lost from the directed motion of the beam during its relaxation in the plasma and the increase in the thermal energy of the plasma particles are determined.

1879 Electric field and structure of weakly ionized plasma near a small charged spheroid. Malyavin, L.A. (Institute of Terrestrial Magnetism, the Ionosphere, and Radio Wave Propagation, Academy of Sciences of the USSR). 3: No. 1, 78-81(Jan 1977).

A study is made of the structure of the perturbations produced by a charged spheroidal object in a weakly ionized plasma. The major semiaxis of the spheroid is assumed small in comparison with the Debye length of the unperturbed plasma. The cases of oblate and prolate spheroids are studied. The distributions of the electric potential and of the electron and ion densities near the object are found for various surface potentials. The total particle currents drawn by the object are calculated. The limiting cases of a sphere, a disk, and a fine wire are studied.

1880 Electric field distribution in a plasma. Babich, L.P. 3: No. 1, 81-83(Jan 1977).

The potential distribution of the self-consistent electric field in a steady-state plasma which is found when the nonlinear field dependence of the space charge density is taken into account differs from the "classical" Debye distribution. The nonlinear screening of the field turns out to be stronger than the Debye screening and is effective over distances shorter than a Debye length. The qualitative nature of the potential distribution is not affected by the nonlinear field dependence.

1881 Energy and incidence-angle distributions of the particles bombarding the wall in a tokamak. Belikov, V.S.; Kolesnichenko, Y.I.; Yavorskii, V.A. (Institute of Nuclear Research, Academy of Sciences of the Ukrainian SSR, Kiev). 3: No. 1, 104-105(Jan 1977).

Calculations are presented on the interactions of neutrons and alpha particles with the first wall of a tokamak reactor.(AIP)

1882 Analytic and numerical studies of Scyllac equilibria. Barnes, D.C.; Brackbill, J.U.; Dagazian, R.Y.; Freidberg, J.P. (Los Alamos Scientific Lab., N.Mex. (USA)); Schneider, W. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)); Betancourt, O. (New York Univ., N.Y. (USA). Courant Inst. of Mathematical Sciences). pp 203-211 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R (6 - 13 Oct 1976).

The results of both numerical and analytic studies of the Scyllac equilibria are presented. Analytic expansions are used to derive equilibrium equations appropriate to non-circular cross-sections, and compute the stellarator fields which produce toroidal force balance. Numerical algorithms are used to solve both the equilibrium equations and the full system of dynamical equations in three dimensions. Numerical equilibria are found for both $l=1,0$ and $l=1,2$ systems. It is found that the stellarator fields which produce equilibria in the $l=1,0$ system are larger for diffuse- than for sharp-boundary plasma profiles, and that the stability of the equilibria depends strongly on the harmonic content of the stellarator fields.

1883 Transport processes and instabilities in magnetically confined plasmas with Tsub(i perpendicular) approximately Tsub(e perpendicular). Basu, B.; Coppi, B.; Molvig, K.; Pegoraro, F. (Massachusetts Inst. of Tech., Cambridge (USA)); Haber, I.; Hui, B.; Palmadesso, P.; Papadopoulos, K.; Winsor, N. (Naval Research Lab., Washington, D.C. (USA)). pp 455-464 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R (6 - 13 Oct 1976).

A series of instabilities and transport processes relevant to high-temperature magnetically confined plasmas with almost equal electron and ion transverse temperatures are presented. These plasma regimes have been realized either as a result of high electron-ion collision rates (high density) or of the excitation of current-driven modes above the ion cyclotron frequency (low density). In the high density regime a model for the anomalous energy diffusion that invokes the excitation of current-driven drift modes below the ion cyclotron frequency is described considering in particular a degree of collisionality for which the current-carrying electron distribution is significantly affected by magnetic trapping. It is also shown that, in this regime, for proper combination of high densities and high temperatures, the stability of the $m^{\theta}=1$ internal kink modes is considerably improved by the simultaneous effects of electrical resistivity, finite ion gyroradius, finite electron drift wave frequency, and ion-ion collisions under realistic conditions. In the low density regime, a combination of Fokker-Planck and particle codes is used to study the positive slope formation and the energy transfer to the ions, resulting from the excitation of modes with frequencies near the ion plasma frequency.

1884 Classical plasma diffusion. Grad, H.; Hu, P.N.; Stevens, D.C.; Turkel, E. (New York Univ., N.Y. (USA). Courant Inst. of Mathematical Sciences). pp 355-365 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R (6 - 13 Oct 1976).

Results obtained from a series of adiabatic and dissipative codes are described which exploit the Grad-Hogan theory of classical transient diffusion and skin penetration. The models include two-dimensions and axial symmetry, a variety of constraints such as specified plasma volume, toroidal and poloidal currents and fluxes, free boundaries in vacuum and force free field, limiters, etc., a variety of topologies, including time-dependent changes of topology (islation, tearing, annihilation of islands). The principal physical results are that, under appropriate circumstances, there is significant quantitative classical disagreement with "classical" (Pfirsch-Schlueter) diffusion and classical skin effect (current penetration). The chief numerical achievements are a family of accurate and efficient algorithms and codes which are useful in their own right and should also provide a basis for a new generation of plasma-modelling, curve-fitting codes (with added atomic physics, radiation, and anomaly factors), but with the geometry and time-dependence treated realistically.

1885 Transport and scaling in the ELMO Bumpy Torus (EBT). Hedrick, C.L.; Dandl, R.A.; Cobble, J.A. (Oak Ridge National Lab., Tenn. (USA)) (and others). pp 145-151 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R (6 - 13 Oct 1976).

In the ELMO Bumpy Torus (EBT) a macroscopically stable regime of operation is expected theoretically and observed experimentally. The power level for microwave bulk heating has recently been doubled to 60 kW, and the resulting plasma parameters scaled encouragingly with this increase in microwave power (e.g. Tsub(i)< approximately 130 eV). The plasma beta for the higher microwave power is approximately 1%; this is still well below the theoretical macroscopic MHD instability limit: a plasma beta comparable to the beta of the hot electron annuli can be stably confined provided a minimum exists in the magnetic field. A radially resolved fluid transport code, based upon refined neoclassical coefficients, yields results which are in reasonable agreement with earlier and recent experimental observations.

1886 Kinetic theory of impurity diffusion in the Pfirsch-Schlueter regime. Rolland, P.; Reuss, J. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Grenoble, 38 (France). Dept. de Physique du Plasma et de la Fusion Controlee; Association Euratom-CEA, Centre d'Etudes Nucleaires de Grenoble, 38 (France). Service Ionique Generale). pp 55-66 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R. (6 - 13 Oct 1976).

The diffusion of impurities in the Pfirsich-Schlueter regime is studied with a kinetic theory using appropriate orderings and Rosenbluth's collision operator. The distributions and fluxes are obtained for all values of the charges Z and densities N. The apparent discrepancy between already published results is explained by the fact that they belong to different domains of validity, clearly specified by this approach.

1887 Two-dimensional fluid simulation of current rise in a tokamak. Webb, S.J. (Imperial Coll. of Science and Technology, London (UK). Dept. of Physics). pp 245-256 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R (6 - 13 Oct 1976).

The observed fast relaxation time of the skin effect in present tokamak discharges cannot be accounted for by neoclassical transport theory; therefore anomalous coefficients for resistivity and energy transport must be introduced in one-dimensional codes. However, in a two-dimensional model there is a possibility that azimuthal variation of the profiles can occur when local plasma heating and the subsequent change in electrical conductivity take place. This may be interpreted as a thermal instability phenomenon. Furthermore, convective cells may be set up due to toroidal effects which convect the profiles into the discharge at a faster rate than diffusion. The initial stages of the current rise phase are studied using

the TICTOK code, which is one-fluid, two-dimensional and Lagrangian. Indications of a regime in which thermal instabilities occur are presented together with simulations in this regime. Preferential heating occurs under these conditions on the inner side of the torus due to a larger deltavectorA/deltat here, followed by an increase in current density. The effects of plasma flow are also considered and two distinct regimes are found that depend on plasma temperature. Transport by heat convection is found to occur. In one regime this is of an oscillatory nature, and in the other the predominant flow is from the body of the plasma to the edges and then round the boundary.

1888 **Problems in plasma theory.** Kiev; Izdatel'stvo Naukova Dumka (1976). 358p. (In Russian). (CONF-741024—).

From 2. international conference on plasma theory; Kiev, USSR (28 Oct 1974).

Abstracts for all of the 58 papers were entered into the data base. (MOW)

1889 **Symmetry of plasma slow motion.** Zhmudskii, A.A. (Kievskij Gosudarstvennyj Univ. (Ukrainian SSR)). **20**: No. 3, 492-496(Mar 1975). (In Russian).

For English translation see the journal Ukr. Phys. J.

An investigation was made of the equations of ion-phonic oscillations from the point of view of groups of continuous transformations. As a result it was possible to find new exact non-linear solutions that describe the automodel dispersion of plasma, movement in a tube of constant cross-section, and centred-wave automodel movement. The discovery of a physical meaning of the solutions corresponding to a symmetry of some kind will be useful when considering the same type of solutions for more complex models.

PLASMA PRODUCTION

1890 **Particle distributions and early phases of ionization in proposed convergent neutral-beam experiments.** Marx, K.D.; Eggens, C.J.; Post, R.F. (Lawrence Livermore Laboratory, Livermore, California 94550). **48**: No. 10, 4215-4228(Oct 1977).

The use of convergent neutral beams to create high-density plasmas is investigated. A detailed study is made of the evolution of the neutral distribution function and the neutral density for both spherical and cylindrical configurations. Ionization rates due to neutral-neutral and ion-neutral collisions are computed, and those due to electron-neutral collisions are estimated. It is concluded that densities of 10^{17} to 10^{18} cm^{-3} could be achieved in spherical systems and that densities of 10^{15} cm^{-3} are possible in cylindrical systems. The ionization rates are sufficiently low that the plasma will not be produced too soon, i.e., before the distribution converges to a final high density.

1891 **Energy transport through high-Z metal foil in a laser-produced plasma.** Mizui, J.; Yamaguchi, N.; Yamanaka, T.; Yamanaka, C. (Institute of Plasma Physics, Nagoya University, Nagoya 464, Japan). **39**: No. 10, 619-622(5 Sep 1977).

Double-layer thin films of high-Z metal and low-Z polyethylene and each single-layer film were irradiated with a 1.06-μm, 200-psec laser pulse at intensities from 10^{14} to 7 x 10^{14} W/cm^2. From the measurements of the transmittance of the laser through these films, the spatial distributions of the transmitted light, expanding ion currents, and x rays, the energy transport is found to be due not only to superthermal electrons but also to x-ray radiation in high-Z material.

1892 **X-ray investigation of the dense plasma of high-pressure pulsed discharges in metal gases.** Glazunov, G.P.; Kantsedal, V.P.; Kosik, N.A.; Mitin, R.B.; Shevstusev, A.P. (Engineering Physics Institute, Academy of Sciences of the Ukrainian SSR, Kharkov). **14**: No. 6, 1054-1058(May 1977).

A dense metal plasma produced by electric explosion of wires is studied. To obtain a more uniform phase composition of the ionized material, the wires were exploded in a high-pressure inert gas (up to 600 atm). The effect of the pressure of the ambient gas on the electric explosion of the conductor is shown. The electric conductivity of a titanium plasma is measured at pressures of 100 and 400 atm. Axial x rays are used to determine the density of a titanium plasma at these pressures with discharge currents of 40 and 35 kA and the density of nickel plasma at 400 atm with a 25-kA discharge current. A description is given of the system for space: time resolution of pulsed arcs in metal gases. The transverse x-ray method is used to measure the radial density distribution for the case of an electric explosion of a nickel wire. The hyperfine (a particle size of 0.01—0.1 μ) metal powder produced by an electric explosion of wires in argon at different pressures was studied. Conclusions are drawn as to the effect of the pressure of the ambient gas on the electrical explosion of the conductor, on the plasma parameters, and on the size of the finely dispersed powder, which is the end product of the process under investigation.

1893 **Two-stage Hall-current plasma accelerator.** Demidenko, I.I.; Lomino, N.S.; Morozov, A.I.; Ovcharenko, V.D.; Padalka, V.G. (Physicotechnical Institute, Academy of Sciences of the Ukrainian SSR, Khar'kov). **3**: No. 1, 31-33(Jan 1977).

A comparative study has been made of the characteristics of single-stage and two-stage Hall-current accelerators with an extended acceleration zone. The incorporation of an additional magnetic lens near the anode increases the average ion energy and reduces the angular divergence of the stream.

1894 **PIG plasma sources.** Brand, G.F. (Sydney Univ. (Australia). School of Physics). **20**: No. 1, 2-7(Jan 1977).

The paper describes PIG plasma sources constructed at Sydney University, and experiments carried out on them.

1895 **Experimental investigation of plasma created by CO_2 laser irradiation of plane targets.** Fabre, E.; Garban, C.; Popovics, C.; Poquerusse, A.; Stenz, C.; Virmont, J. (Ecole Polytechnique, 91 - Palaiseau (France)). pp 597-602 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R. (6 - 13 Oct 1976).

Ion energy, electron temperature, back-reflection and harmonics generation have been investigated in CO_2 laser target irradiation experiments. A fast-ion component is observed to be clearly correlated with the supra-thermal electron component. The (Isub(ω))$^{2/3}$ scaling law for these species and the fact that no clear threshold has been observed are in favour of the assumption of resonance absorption. Spectral analysis of the back-reflection at ω shows a small contribution from Brillouin back-scattering. Refraction losses are dominant. Harmonics of the laser frequency, $(3/2)\omega$, 2ω, are observed and spectrally resolved. Their generation involves instability processes and, from the $(3/2)\omega$ emission, the threshold for the two-plasmon instability is determined. A 3ω harmonic is also detected.

1896 **Filling of toroidal traps with laser plasmas.** Spalding, I.J.; Armandillo, E.; Donaldson, T.P.; Kachen, G.I.; Walker, A.C.; Ward, S. (UKAEA Research Group, Abingdon. Culham Lab.). pp 589-596 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R. (6 - 13 Oct 1976).

New results have been obtained in generating energetic CO_2 laser pulses of variable duration and in related heating investigations for the single-target laser-plasma filling of toroidal magnetic traps. Pulses of order 1kJ have been reliably produced on the time scales of interest. KeV-plasmas are readily produced at lower energies, and at intensities approximately $< 10^{13} Wcm^{-2}$; the plane-target absorption efficiency is high, despite the long wavelength, because of non-classical effects which are investigated experimentally. Factors affecting the coupling efficiency to smaller low-Z targets are also discussed.

1897 **ν/γ approximately 1 diode characters for intense relativistic electron beams.** Takagi, K. (Nagoya Univ. (Japan). Faculty of Engineering); Miyahara, A. **15**: No. 12, 2477-2478(Dec 1976).

Published in summary form only.

1898 **Optimum anode-cathode spacing in a reflex triode ion source.** Okada, C.; Kamada, K.; Ono, H.; Ishizuka, H. (Tokyo Univ. of Education (Japan). Faculty of Science); Nemoto, N. **15**: No. 8, 1615-1616(Aug 1976).

Published in summary form only.

PLASMA INSTABILITIES

REFER ALSO TO CITATION(S) 1983

1899 (COO—2456-46) **Survey of linear MHD stability in tokamak configurations.** Wakatani, M. 1977. Contract EY-76-S-02-2456. 65p. Dep. NTIS, PC A04/MF A01.

The results found by MHD stability studies for both low-beta and high-beta tokamaks are reviewed. The stability against kink-ballooning modes in equilibria surrounded by vacuum or a layer of force free currents is considered. Internal kink modes and the relation to interchange modes, which should be considered after external kink modes are suppressed, are surveyed. (MOW)

1900 (PPPL—1358) **Alfven instability and micromagnetic islands in a plasma with sheared magnetic fields.** Hsu, J.; Kaw, P.; Chen, L. Jul 1977. Contract EY-76-C-02-3073. 14p. Dep. NTIS, PC A02/MF A01.

The normal mode equation for coupled drift and Alfven waves in a finite-β nonuniform plasma with a sheared magnetic field is solved, in the slab geometry, to investigate the instability of slow Alfven waves. It is shown, that, besides having an appreciable

growth rate, the instability also produces microscopic "tearing" of the rational surfaces which has important implications for anomalous transport.

1901 (TID—27157) **Introduction to trapped-particle instability in tokamaks. ERDA Critical Review Series.** Manheimer, W.M. 1977. Contract RL-75-6507. 104p. Dep. NTIS, PC A06/MF A01.

Comprehensive discussions are given for each of the following chapters: (1) effects of transport on Tokamak discharges, (2) drift waves in an inhomogeneous plasma, (3) conditions for drift wave instability, (4) drift wave destabilized by a small population of trapped electrons, (5) shear stabilization of drift-wave instabilities, (6) further discussion of shear stabilization, (7) a collection of formulas concerning the magnetic field and particle orbits in a torus, (8) Vlasov theory of the trapped-electron response, (9) variational calculation of eigenfunctions and eigenvalues, and (10) anomalous transport from trapped-particle instabilities. (MOW)

1902 Nonlinear saturation of the dissipative trapped-electron instability. Chen, L.; Berger, R.L.; Lominadze, J.G.; Rosenbluth, M.N.; Rutherford, P.H. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). **39**: No. 12, 754-757(19 Sep 1977).

It is shown that trapping-electron—induced scattering can be dominant over nonlinear ion Landau damping in the saturation of short-wavelength, dispersive, trapped-electron instabilities in tokamaks. Trapped-electron-induced scattering transfers the wave energy to shorter wavelengths, where it can be dissipated by ion viscosity.

1903 Measurements of finite-bandwidth effects on a parametric instability. Mizuno, K.; DeGroot, J.S. (Department of Applied Science, University of California, Davis, California 95616). **39**: No. 10, 608-611(5 Sep 1977).

The effects of broadband (stochastic) pump on the parametric decay instability is studied experimentally. The growth rate decreases with pumb bandwidth, $\Delta\omega$, as if only the fraction of the pump power within the resonance width is available to drive the stability, in agreement with theory. The saturated wave amplitude and suprathermal-electron production well above threshold are only slightly decreased (for bandwidths presently available, $\Delta\omega/\omega 9$ or $\approx 3 \times 10^{-3}$) in agreement with simulation calculations.

1904 Enhanced backscatter with a structured laser pulse. Ripin, B.H.; Young, F.C.; Stamper, J.A.; Armstrong, C.M.; Decoste, R.; McLean, E.A.; Bodner, S.E. (Naval Research Laboratory, Washington, D. C. 20375). **39**: No. 10, 611-615(5 Sep 1977).

A large-amplitude backscatter instability, consistent with Brillouin, occurs when a prepulse plasma is formed ahead of a high-irradiance (10^{15}—10^{16} W/cm^2) Nd-laser pulse. These results indicate that temporally structured laser pulses suggested for laser pellet implosion may also encounter large backscatter.

1905 Parametric coupling of a large-amplitude whistler wave with ion quasimodes in plasmas. Shukla, P.K. (Institut fuer Theoretische Physik, Ruhr-Universitaet Bochum, 463 Bochum, Federal Republic of Germany). **16**: No. 3, 1294-1296(Sep 1977).

We consider the nonlinear interaction between ion quasimodes and a large-amplitude electron whistler wave propagating at an angle to the external magnetic field. It is found that this interaction leads to an instability. The growth rate and threshold are calculated.

1906 Parametric rotation of the principal polarization axes and other effects due to four transverse waves in a plasma. Chakraborty, B. (Department of Mathematics, Jadavpur University, Calcutta-32, India). **16**: No. 3, 1297-1308(Sep 1977).

Four elliptically polarized waves acting in a cold and unmagnetized plasma are shown to be responsible for the parametric evolution in time of the rotation of the principal polarization axes (the precession frequency) and some other nonlinear effects in two evolving waves by two other powerful waves. The investigation requires the transition from the macroscopic to a new type of more general and vivid microscopic study of parametric processes due to transverse waves in continuous media. The parametric precession frequency (PPF), when complex, is a new source of instability in plasmas. Complex PPF and complex parametric frequency shift occur in some near-resonant interactions in which the sum or difference between two frequencies is close to the characteristic frequency of electrons in a plasma. It is found that when the plasma is subjected to two strong fields, sharp bands of monochromatic noise transform into growing continuous spectra.

1907 Instability of dissociative adhesion in crossed E and B fields. Dresvyannikov, V.G.; Fisun, O.I. (Institute of Electrodynamics, Academy of Sciences of the Ukrainian SSR). **14**: No. 6, 1140-1144(May 1977).

On the basis of linear hydrodynamic theory, an investigation is made of the stability of a magnetized plasma of a molecular gas with an easily ionized additive, in which the main reaction of dissociative adhesion is the process of the formation of negative ions. The case of the absence of ionization equilibrium is discussed. It is known that, in the long-wave region of perturbations, there is the possibility of oscillation of the mode of dissociative adhesion, with an increment depending on the Hall parameter and the direction of the propagation of the wave. The stability criteria and the threshold concentrations of the additive and the negative ions are found. The possibility of the development of instability, based on the dependence of the reaction constants on the temperature of the gas is pointed out.

1908 Velocity gradient driven flute instabilities in plasmas. Sinha, M.; Sundaram, A.K. (Physical Research Lab., Ahmedabad (India)). **8**: No. 3, 205-213(Mar 1977).

12 refs.

The effect of velocity gradient across the magnetic field on the low frequency flute modes is examined in detail, using the normal mode analysis. It is shown that some new type of instabilities driven primarily by the velocity gradient arise and these excited modes eventually attain the convective saturation. The onset of plasma turbulence due to these instabilities may possibly be one of the major contributors for anomalous heating process and enhanced plasma resistivity.

1909 Gravity induced magnetic instability. Sinha, M. (Physical Research Lab., Ahmedabad (India)). **8**: No. 3, 214-216(Mar 1977).

In the presence of a gravitational field the stability of a magnetoplasma is studied against electromagnetic perturbations. It has been shown that a pinching type of instability can be triggered with a sizable growth rate affecting the equilibrium configuration of the confining magnetic field. This might have a profound effect on the magnetic fields of astrophysical bodies.

1910 Plasma-stability region in the T-9 finger-ring tokamak. Bortnikov, A.V.; Brevnov, N.N.; Gerasimov, S.N.; Zhukovskii, V.G.; Pergament, V.I.; Kimchenko, L.N. (I. V. Kurchatov Institute of Atomic Energy, Moscow). **3**: No. 2, 110-115(Mar 1977).

An experimental study is made of the region of plasma stability on a plot of the discharge current vs the average plasma density for the T-9 finger-ring tokamak. It is found that the stability region has three boundaries, as in an ordinary tokamak. The processes operating at the left boundary (at a low plasma density) and at the upper boundary (the maximum current in the plasma) of the stability region in the T-9 are generally similar to those in an ordinary tokamak. At the right boundary of the stability region the processes are governed by a critical-density instability and have several new features. For example, in contrast with the situation in an ordinary tokamak, the instability involves an expansion of the current channel in the plasma, and the behavior of the boundary as a function of the plasma density is different. The differences are apparently due to the onset of a balloon instability.

1911 Langmuir-probe study of the wall region in the TM-3 tokamak. Bobrovskii, G.A.; Kondrat'ev, A.A. (I. V. Kurchatov Institute of Atomic Energy, Moscow). **3**: No. 2, 115-117(Mar 1977).

Double Langmuir probes have been used to measure the radial profiles of the electron temperature and density in the shadow of the limiter in the tokamak. In the immediate vicinity of the wall the electron density is a few times 10^{10} cm^{-3}, independent of the initial pressure and the discharge current. The oscillations in the saturation current have clearly defined maxima when the probe passes resonant magnetic surfaces in the shadow of the limiter. It is suggested that these oscillations lead to an additional escape of charged particles to the wall and to additional desorption.

1912 Collective processes in the injection of fast neutrals into a tokamak with a noncircular cross section. Bardakov, V.M.; Mikhailovskii, A.B. (I. V. Kurchatov Institute of Atomic Energy, Moscow). **3**: No. 2, 121-126(Mar 1977).

The collective processes which can occur when a beam of fast neutral atoms is injected into a tokamak of noncircular cross section are studied. These processes are assumed to be due to the excitation of Alfven waves by fast ions formed through ionization of the neutral atoms. The linear growth rate of the Alfven waves in a tokamak of noncircular cross section is calculated; the poloidal dependence of the poloidal magnetic field is taken into account. A problem of the O'Neil type is solved for the case of the noncircular tokamak. Equations describing the quasilinear relaxation of fast ions in a noncircular tokamak are derived. It is concluded that the nonlinear cross section can lead to the appearance of additional instability branches and to additional non-Coulombic relaxation processes.

1913 Thermonuclear Alfven instabilities in a tokamak reactor. Belikov, V.S.; Kolesnichenko, Y.I.; Mikhailovskii, A.B.; Yavorskii, V.A. (I. V. Kurchatov Institute of Atomic Energy, Moscow). **3**: No. 2, 146-149(Mar 1977).

An analysis is made of thermonuclear Alfven instabilities in a tokamak reactor. The perturbations have longitudinal wavelength

less than or on the order of the length $2\pi qR$ of a magnetic line of force around the torus i.e., k/sub parallel q R(approximately-greater-than1kparallel/ is the longitudinal wavenumber, R is the radius of the magnetic axis of the torus, and q is the safety factor fo the tokamak). In particular, perturbations of this type give rise to an instability of untrapped α particles at cyclotron resonances (k/sub parallel q R)/and an instability of trapped α particles at low-frequency bounce resonances (k/sub parallel q R)/The effect of the toroidal nature of the system on the first of these instabilities is studied, and it is found that the approximation of a straight magnetic field can be used for this purpose. A threshold is associated with the instabilities due to the damping of Alfven waves by trapped electrons.

1914 Modulational plasma-wave instability due to oscillations in the relativistic electron mass. Tsivtsivadze, T.A.; Tsintsadze, N.L. (Institute of Physics, Academy of Sciences of the Georgian SSR, Tbilisi). **3**: No. 2, 154-155(Mar 1977).

The nonlinearity in the parametric resonance in a plasma due to oscillations in the relativistic electron mass is analyzed. In the slightly relativistic case the oscillation amplitude increases exponentially, and when the amplitude of the external electromagnetic field is increased there is a temporal modulation of the waves.

1915 Parametric decay in inhomogeneous plasma. Silin, V.P.; Starodub, A.N. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). **3**: No. 2, 156-162(Mar 1977).

It is shown that an absolute instability arising from the spatial variation of the pump wave can occur in an inhomogeneous plasma. An analysis is carried out for the example of the parametric conversion of a pump wave into a plasma wave and an ion-acoustic wave. In this instability, the perturbations whose amplitudes grow over time are confined to the regions in which the pump field has extrema. Perturbations of two types grow in the plasma; the thresholds for the excitation of these perturbations are determined. Under conditions of interest for controlled fusion reactions caused by laser irradiation of solid targets, the instability threshold is governed substantially by the plasma inhomogeneity. This threshold is much higher than that in a homogeneous plasma. The effect of pump absorption on the parametric decay is analyzed.

1916 Stability of an elliptical plasma cylinder carrying a current in a conducting discharge chamber of arbitrary shape. Danilov, A.F.; Popov, A.M. (M. V. Lomonosov Moscow State University). **3**: No. 2, 162-166(Mar 1977).

The stability of a plasma of elliptical profile, carrying a homogeneous current, is analyzed through a numerical solution of the ideal, two-dimensional MHD equations for an incompressible fluid. The plasma is enclosed by perfectly conducting walls of arbitrary profile. An equilibrium plasma profile with an elongated cross section can be produced by means of external current-carrying conductors. In this case there is a magnetic-surface separatrix around the plasma. The effect of this separatrix on the stability of displacements of the plasma as a whole along the major semiaxis is determined. A study is made of the possibility of devising an equilibrium configuration which would be stable when the separatrix lies entirely within the chamber. A dispersion relation for axisymmetric waves is derived for the case of walls confocal with the plasma boundary. This relation shows that the only stable configurations are those for which the stationary point of the separatrix lies outside the chamber. When the plasma is enclosed in an elliptical (not confocal) or rectangular chamber, it is possible to achieve stability with the separatrix within the chamber by reducing the width of the vacuum region beside the plasma. A new unstable mode is found in the case of a highly elongated chamber cross section.

1917 Feedback stabilization of flute modes. Gribkov, V.M. (M. V. Lomonsov Moscow State University). **3**: No. 2, 167-171(Mar 1977).

The stabilization of flute modes in a plasma in a straight confinement system by means of a feedback system is studied. The feedback system measures the radial component of the perturbed electric field. The plasma is assumed bounded along the z axis; the detectors and control electrodes can be placed at various distances from the axis. The instability thresholds are found as functions of the feedback ratio and the position of the measuring probe for a parabolic plasma density profile and for a profile approximating the experimental profile. The influence of a gradient of the magnetic field and a finite plasma dimension on the threshold density is studied.

1918 Suppression of loss-cone instabilities in a mirror system with a tailored magnetic field. Arsenin, V.V.; Pastukhov, V.P. (I. V. Kurchatov Institute of Atomic Energy, Moscow). **3**: No. 2, 172-174(Mar 1977).

If the magnetic field in front of the mirrors in a mirror system is slightly reduced, the result is an additional region in which low-energy ions are confined. When a few such ions are present, the loss-cone instabilities are known to be suppressed. Because of the confinement of the low-energy ions in the system, their density can be held at the level necessary for stabilization at a relatively low cost in energy.

1919 Mechanism for efficient collisionless interaction of an ion beam with a plasma in a transverse magnetic field. Borisenko, A.G.; Kirichenko, G.S. (Institute of Nuclear Research, Academy of Sciences of the Ukrainian SSR, Kiev). **3**: No. 2, 198-201(Mar 1977).

The excitation of the lower hybrid branch of longitudinal waves by an ion beam injected across the magnetic field into a plasma is studied. The wave spectra and growth rates and the influence of these waves on the velocity distribution of the beam ions are studied for plasma densities in the range 10^9—10^{10} cm^{-1}, for an electron temperature ~10 eV, for an ion temperature ~1 eV, for a monoenergetic-beam current of 1—2 mA, for energies 0-500 eV, for magnetic fields up to 300 Oe, and for a transit distance of 10 cm. The conditions for the onset of the instability are optimal when the plasma density and the magnetic field are such that the ratio of the electron gyrofrequency to the electron plasma frequency is ω/sub He//ω/sub pe/9 or ≈ 1. In the nonlinear stage the velocity spectrum of the beam ions develops into a plateau; i.e., the beam is essentially thermalized in the plasma. These effects can occur in fusion confinement systems with external injection.

1920 Suppression of many spatial flute modes in a mirror system by a feedback system with one detector and one electrode. Arsenin, V.V. (I. V. Kurchatov Institute of Atomic Energy, Moscow). **3**: No. 1, 14-17(Jan 1977).

Previous experiments have confirmed the theoretical prediction that several spatial modes can be suppressed simultaneously with a relatively simple external-circuit transfer function by using a large number of perturbation detectors and suppression elements (probes, electrodes, coils, etc.). Engineering considerations require that the number of these elements be minimized. In the present paper it is shown that, if the spatial modes also differ in frequency spectrum, all can be suppressed by a single system consisting of a single detector and a single suppressing element (or by two such pairs, if standing waves grow). Here the transfer function of the external feedback circuit must have a special frequency dependence. A special study is made of the suppression of flute modes in a mirror system with a single side electrode.

1921 Excitation of shortwave trapped-electron mode by fast ions. Mikhailovskii, A.B. (I. V. Kurchatov Institute of Atomic Energy, Moscow). **3**: No. 1, 43-44(Jan 1977).

A study is made of the role played by electron collisions in the excitation of the shortwave trapped-electron mode by fast ions discussed previously by Coppi and Bhadra. Under typical tokamak conditions, the damping rate for this mode due to electron collisions is large in comparison with the growth rate found by Coppi and Bhadra. Accordingly, the instabilities predicted by Coppi and Bhadra cannot occur under real conditions.

1922 Suppression of the flute instability. Krasheninnikov, S.I.; Soboleva, T.K. (Moscow Physicotechnical Institute). **3**: No. 1, 50-55(Jan 1977).

The suppression of the flute instability by high-frequency oscillations of the magnetic lines of force and by a magnetosonic wave is analyzed. A study is made of both the usual case, in which the frequency of the high-frequency magnetic field, Ω, is higher than the collision frequency ν/sub e i/, and the case in which ν/sub e i/ is larger than Ω. This latter case can occur in plasma centrifuges. It is shown that even at comparatively low amplitudes of the alternating field, $H_1/H_0 \sim$ (1—10) x10^{-4}, the flute instability can be suppressed.

1923 Excitation of regular transverse plasma waves of finite amplitude by a bounded relativistic electron beam. Krasovitskii, V.B. (Rostov State University). **3**: No. 1, 60-64(Jan 1977).

A nonlinear theory is derived for the interaction of a bounded, low-density relativistic beam with a plasma in the absence of an external magnetic field. The beam radius is assumed small in comparison with the wavelength. The quasitransverse plasma waves excited by this "narrow" beam are studied. A detailed study of the cases of unmodulated, modulated, and deeply modulated beams is carried out in the nonlinear approximation. The limiting case of a deeply modulated beam corresponds to a train of charged disks. The physical structure of the nonlinear transverse waves which result from the beam—plasma interaction is determined.

1924 Nonlinear dynamics of the beam instability in a bounded plasma. Al'terkop, B.A.; Volokitin, A.S.; Rosinskii, V.E.; Rukhadze, A.A.; Tarakanov, V.P. (Institute of High Temperatures, Academy of Sciences of the USSR). **3**: No. 1, 100-102(Jan 1977).

The interaction of an electron beam with a plasma is considered in the case in which the beam and plasma completely fill the waveguide cross section. The damping of the resultant nonlinear oscillations is calculated.(AIP)

1925 Numerical computation of MHD spectrum of non-circular, small-aspect-ratio tokamaks. Berger, D.; Bernard, L.C.; Gruber, R.; Troyon, F. (Ecole Polytechnique Federale, Lausanne (Switzerland)).

pp 411-420 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R. (6 - 13 Oct 1976).

A spectral code has been developed to compute the ideal MHD spectrum of axisymmetric toroidal plasmas of arbitrary cross-section; it is applied to the Soloviev equilibrium. The aspect ratio is kept fixed to 3. The corresponding ratio between the safety factors at the edge and on the axis qsub(s)/q(0) is equal to 1.74. Two different shapes are considered: an almost circular cross-section and a D-shaped elongated cross-section with a half-axis ratio of 2. The two extreme cases of no conducting shell round the plasma and of the shell tight against the plasma surface are treated. The growthrate of the most unstable mode is plotted versus q(0). In the rigid boundary limit the low n modes are found to be stable above the value of qsub(0), which is below the Mercier limit. The structure of the modes shows the combined effects of shear and toricity. The calculation is repeated for the free boundary case. The growthrate of the kink plotted versus q(0) has the same general behaviour as in the straight case, but the modes show a complicated structure which can be construed as a coupling between an internal mode and a kink of different m through the toricity.

1926 Diffusion and fluctuation measurements in the trapped-electron and trapped-ion regimes. Drake, J.R.; Kerst, D.W.; Navratil, G.A.; Post, R.S. (Wisconsin Univ., Madison (USA)); Ejima, S.; LaHaye, R.; Moeller, C.P.; Ohkawa, T.; Petersen, P.I.; Prater, R. pp 333-341 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R (6 - 13 Oct 1976).

Experiments have been performed in the Wisconsin Levitated Octupole with a weak toroidal magnetic field added to the octupole field. When the ions were collisionless or collisional, the diffusion scaling observed in the absolute minimum-B regions indicated convective diffusion driven by mirror-trapped electrons. When the ions were collisionless, both a dissipative trapped-ion mode and a collisionless trapped-ion mode were observed in the average minimum-B region. These modes were distinguished by their propagation direction in the plasma frame and were not present without the weak toroidal field or when the ions were made collisional. When these modes were present, the plasma transport was increased by an order of magnitude. Experiments have been performed in the General Atomic dc Octopole in the regimes in which dissipative trapped electron and trapped ion modes are expected to occur. Dissipative trapped-electron modes have been observed and studied in detail. The trapped-ion regime has been attained by means of rf ion heating at the lower hybrid frequency, and fluctuations that appear to be collisionless ion drift waves driven by ion Landau resonances have been observed in the private flux regions. These ion modes may provide a confinement limit on tokamaks that are operated in parameter ranges for which the dissipative trapped-particle modes are unimportant.

1927 Non-linear transport due to collisional drift wave and interpretation of related experiments. Hatori, T.; Nishikawa, K.I.; Terashima, Y. (Nagoya Univ. (Japan). Inst. of Plasma Physics); Dodo, T.; Okada, O. (Hitachi Ltd., Kokubunji, Tokyo (Japan). Central Research Lab.). pp 345-349 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R (6 - 13 Oct 1976).

The non-linear development of a plasma with an unstable collisional drift wave is studied by using two-fluid equations. The set of the non-linear equations for modification of background density and drift mode amplitude is derived by an asymptotic expansion method, which describes well the transition to higher instabilities and non-linear transport. It is shown that stable stationary convective motion exists only for limited values of a critical number, the ratio of viscosity damping to linear growth rate. As this critical number decreases, the number of unstable modes increases, and, usually, a bifurcation of non-linear steady states is obtained. Expressions for particle and heat transport are obtained. A comparison of these results with the experiments of a stellarator device is also made.

1928 Experimental and theoretical study of the FLR stabilization in the high-beta-stellarator - equilibrium and stability of MHD-configurations with zero rotational transform. Herrnegger, F.; Kaufmann, M.; Lortz, D.; Neuhauser, J.; Nuehrenberg, J.; Schneider, W.; Schramm, G. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). pp 183-189 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R (6 - 13 Oct 1976).

The influence of a finite Larmor radius (FLR) on the stability of unstable MHD modes has been investigated experimentally and theoretically. Experiments on the high-beta stellarator (HBS) ISAR T1-B with an extremely large helical amplitude (delta$_1$ approximately equal to 3) showed stabilization for the m=2, k approximately 0 mode as long as rsub(L)/a approximately >0.14. This critical ratio was smaller by a factor of 2 to 4 than that given by sharp-boundary calculations and insensitive to ωsub(L)tausub(ii) which varied from 2 to 10 at the critical limit. Theoretically, the initial-value problem of the MHD-equations including gyro-viscosity was solved in cylindrical and helical symmetry with diffuse profiles. Numerically, an implicit method was used for the gyro-viscosity term. Eigenfunctions and growth rates of m=2 modes could be determined at different rsub(L)/a. B. Equilibrium and stability of toroidal finite-β MHD-configurations with a plane magnetic axis and zero rotational transform are investigated. A new sufficient stability criterion is used which, for this case, coincides with Mercier's necessary stability criterion in the neighbourhood of the magnetic axis. Critical β values, βsub(c), are computed from the position of the separatrix of the self-consistent third-order (in the distance from the magnetic axis) equilibrium solution. Optimization of βsub(c) with respect to all prescribable functions yields a monotonically increasing βsub(c) as a function of the number of periods around the torus. In contrast to the data in the existing literature, rather low values of βsub(c) are obtained, e.g. about 10% for 100 periods.

1929 Correlations between drift wave theory, particle simulations and the observed anomalous transport in tokamaks. Horton, W. Jr. (Texas Univ., Austin (USA)); Okuda, H.; Cheng, C.Z.; Kuo, Y.Y.; Lee, W.W.; Matsuda, Y.; True, M. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). pp 467-478 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R (6 - 13 Oct 1976).

The drift wave model for anomalous plasma transport is developed further by analytic theory and 21/2D particle simulations. The predictions of theory are used to analyse the computer experiments and the tokamak experiments. A study of the problem of anomalous electron thermal transport and the fluctuation spectrum in the drift wave frequency range is summarized with respect to experiments in TFR, ATC, ST, Ormak and Alcator.

1930 Computational study of axisymmetric modes in non-circular cross-section tokamaks. Johnson, J.L.; Chance, M.S.; Greene, J.M.; Grimm, R.C.; Jardin, S.C.; Kerner, W.; Manickam, J.; Weimer, K.E. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). pp 395-400 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R (6 - 13 Oct 1976).

A major computational program to investigate the MHD-equilibrium, stability, and non-linear evolution properties of realistic tokamak configurations is proceeding. Preliminary application is made to the Princeton PDX device. Both axisymmetric (n=0) modes and kink (n=1) modes are found; the growth rates depend sensitively on the configuration. A study of the non-linear evolution of axisymmetric modes in such a device shows that flux conservation in the vacuum region can limit their growth.

1931 Effects of impurity ions on the trapped-ion instability and on the transport coefficient. Sugimoto, H.; Chiyoda, K. (Electrotechnical Lab., Tanashi, Tokyo (Japan). Tanashi Branch). pp 499-507 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R (6 - 13 Oct 1976).

The dissipative trapped-ion instability is predicted to be one of the most dangerous instabilities in tokamak plasmas in the fusion-reactor regime. The important role of impurity ions have been widely recognized in determining the energy loss. The dissipative trapped-ion instability in a plasma with many species of ions is analysed in terms of Kadomtsev's weak-turbulence theory. Particle diffusion and thermal conduction are analysed by mode-coupling interaction. The basic equations used are a drift kinetic equation and Poisson's equation. From the equation for the fluctuation of the distribution function and Poisson's equation, the wave kinetic equation with wave-particle and wave-wave non-linear interactions is derived. The characteristic frequency, ωsub(k vector), does not satisfy the decay condition. The wave-wave non-linear interaction, therefore, vanishes. The saturation wave energy is determined by the non-linear damping of the wave on trapped ions, and the spectrum is isotropic. The equation for the ensemble average distribution func-

tion gives the diffusion coefficient and the thermal conductivity for electrons and each species of ions. The impurity ions present decrease the wave energy. Particle diffusion and thermal conduction will, therefore, be reduced, compared to that given by the Kadomtsev-Pogutse formula. Typical applications of the result will be presented.

1932 Does magnetic shear stabilize drift waves. Taylor, J.B. (UKAEA Research Group, Abingdon. Culham Lab.). pp 323-329 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R (6 - 13 Oct 1976).

In the uniform plane slab, shear in the magnetic field produces an inherent damping of drift waves. This damping arises because, in the presence of shear, a mode centred on a given magnetic surface radiates energy outwards from that surface. However, in a realistic system, where the field strength and shear are not uniform, waves associated with different surfaces are coupled together. This changes the propagation of drift waves and radiation is inhibited or reflected. If the shear or the magnetic field is sufficiently non-uniform the drift wave reverts to a non-propagating mode in which there is no intrinsic shear damping. The mode is then governed by the density profile as if shear were absent. Consequently, in a real system drift waves may be unstable even though the conventional criteria for shear stabilization appear well satisfied.

1933 Equilibrium and stability of high-beta plasma in Modified Bumpy Torus (MBT). Todoroki, J.; Shiina, S.; Saito, K.; Osanai, Y.; Nogi, Y.; Gesso, H.; Yagi, I.; Yokoyama, K.; Yoshimura, H. (Nihon Univ., Tokyo. Dept. of Physics; Nihon Univ., Tokyo. Atomic Energy Research Inst.). pp 215-221 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R. (6 - 13 Oct 1976).

The equilibrium and stability properties of the plasma in Modified Bumpy Torus, which is an asymmetric system with closed magnetic lines of force, is reported. For small beta value, the growth rate of m=1 mode instability in MBT can be smaller than that of Scyllac configuration. The results of 1/4 toroidal sector experiment are reported.

1934 Equilibrium and MHD stability of a plasma in stellarators with spatial magnetic axis. Zakharov, L.E.; Shafranov, V.D. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). pp 155-167 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R (6 - 13 Oct 1976).

Certain aspects of the theory of toroidal systems with three-dimensional axes are considered. A class of simple closed curves the torsion of which has a relative curvature containing only two Fourier coefficients is defined. Relationships are obtained between these coefficients and the average torsion ensuring that the curves are closed. The equilibrium of a non-axisymmetric plasma column in the presence of a longitudinal current is considered. The confining fields which ensure equilibrium of a plasma column with an arbitrary type of axis and displacement of the plasma column with respect to the magnetic axis of the vacuum field are determined. An equation of pressure balance which relates the diamagnetic signal to the plasma pressure and current is derived for stellarator systems. The stability of a plasma column in stellarators with three-dimensional axes with respect to transverse displacements of the plasma as a whole is demonstrated. Consideration is given to the fact that the conditions for helical stability of a current-carrying plasma are more easily satisfied when an external rotational transform is generated. It is shown that the conditions of Mercier stability are sufficient for a plasma with a fixed boundary.

1935 Numerical studies of resistive instabilities. Biskamp, D.; Welter, H. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). pp 579-589 of In Plasma physics and controlled nuclear fusion research, 1976. Vol. I. Vienna; International Atomic Energy Agency (1977).

Linear and nonlinear properties of the m = 2 tearing instability are investigated. The growth rate γ is obtained for finite values of the resistivity eta. It is found that even for eta approximately 10^{-6}, γ may be substantially smaller than predicted previously. The nonlinear behavior is studied for different models of the resistivity. Stabilization of island growth occurs for delta eta/sub i//delta psi < 0 (eta/sub i/ is the resistivity within the islands) as produced, e.g., by the thermal conductivity kappa/sub perpendicular to/, while no saturation is found for delta eta/sub i/delta psi > 0. In addition, the interaction of rotating tearing modes with a weak external resonant field is investigated.

1936 Positional instabilities of a plasma in a tokamak with a magnetic limiter. Ninomiya, H.; Suzuki, Y.; Kameari, A. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). **15**: No. 11, 2201-2210(Nov 1976).

The stability conditions of a plasma with respect to its rigid vertical displacement and horizontal expansion are numerically studied for a tokamak with magnetic limiters. The stability regions are discussed in terms of the decay index n of the equilibrating vertical field at the center of the plasma cross section. The plasma is stable up to n=2.32 for the horizontal expansion even when a magnetic limiter is located in the outer side of the plasma cross section. For the vertical displacement, the plasma is stable even if n=-1.16 when magnetic limiters exist in the upper and lower sides of the plasma cross section. These results indicate that the uniformly displaced plasma is stabilized by the existence of the auxiliary coils, because the current flowing in the coils makes the curvature of the magnetic field lines convex to the plasma.

1937 Development of Taylor instability in compressible conducting systems situated in a magnetic field. Polianin, A.D. 15-19(1975). (In Russian).

The stability of the interface of two compressible conducting media situated in a magnetic field is analyzed, assuming that the magnetic field intensity may exhibit a discontinuity along the interface, and that the magnetic field vector is constant for both media and is located in plane normal to the z axis. A relation between the maximal instability increment and the governing parameters is derived. The stability of a contact discontinuity is analyzed as a function of the angles formed by the wave vector and the magnetic field vector.

PLASMA WAVE PHENOMENA

1938 (LPS—224) Lower hybrid wave propagation in inhomogeneous plasmas. Ott, E.; Liu, C.S. May 1976. Contract EY-76-S-05-3405. 9p. Dep. NTIS, PC A02/MF A01.

Lower hybrid waves produced either by instabilities or by parametric decay of a pump wave can have appreciable components of their wave vectors in the direction B/sub approx 0/ x Nabla N. This note examines the consequences of this for propagation in inhomogeneous plasmas.

1939 (UCRL—13752) Microwave simulation of laser plasma interactions. Final report. 14 May 1977. Contract W-7405-ENG-48-7950105. 43p. Dep. NTIS, PC A03/MF A01.

Various electron and ion current, electric field, and magnetic field probes were developed and tested during the course of the investigation. A three dimensional probe drive system was constructed in order to investigate two and three dimensional phenomena occurring in the microwave plasma interaction. In most of the experiments reported here, a 1 GHz, 40 kilowatt, pulsed rf source (Applied Microwave), was used. The antenna was a 20° horn. A dipole fed parabolic antenna system capable of producing a focussed microwave beam at 2.3 GHz was developed and bench tested. This system will be used in future investigations at higher power levels ($E_o^2/8\pi$nkappaT > 1).

1940 (UCRL—79334) Electrostatic ion cyclotron waves and ion energy diffusion in a mirror machine. Turner, W.C. 1 Aug 1977. Contract W-7405-ENG-48. 42p. (CONF-770660—1). Dep. NTIS, PC A03/MF A01.

From IRAP congress; Palaiseau, France (27 Jun 1977).

Measurements of ion cyclotron fluctuations and ion energy diffusion in the neutral beam injected 2XIIB mirror machine are presented. A narrow band single mode spectrum is always observed. When the plasma is de-stabilized by turning off axially injected streaming plasma, the wave amplitude increases and a simultaneous increase in ion-energy diffusion is observed. The spectral properties of the wave do not change. The data are in accord with a wave particle saturation of the drift cyclotron loss cone (DCLC) mode.

1941 Resonant enhancement of the magnetic radiative force. Stamper, J.A. (Naval Research Laboratory, Washington, D. C. 20375). **31**: No. 9, 574-575(1 Nov 1977).

Earlier work described a polarization-dependent radiation force for laser radiation interacting with a magnetized plasma. A new derivation, based on the upper-hybrid mode, shows that this force has a resonant enhancement and implies its relation to a magnetic type of resonant absorption.

1942 Experimental study of the propagation of ion acoustic solitons in a warm multi-ion plasma. Tran, M.Q.; Hollenstein, C. (Centre de Recherche en Physique des Plasmas, Ecole Polytechnique Federale de Lausanne, CH-1007 Lausanne, Switzerland). **16**: No. 3, 1284-1293(Sep 1977).

The formation of ion acoustic solitons in an argon-helium plasma is studied as a function of the light-ion concentration. It is found that an initial perturbation does not break into solitons for 1% 9 or $\approx$ α 9 or $\approx$ 66%. This fact can be related to an increase in

linear Landau damping and to nonlinear resonant particles, i.e., reflected ions in front of the potential hump and eventually trapped ions between two solitons. In the concentration range where solitons are formed (essentially for $\alpha >$ or $\approx$ 66%) the soliton's Mach number and width follow qualitatively the well-known theoretical dependence on amplitude. Detailed studies show, however, that the measured Mach number cannot be explained by fluid theories (namely the Korteweg—de Vries equation and Sakanaka's theory). Stationary solutions from theory which takes into account trapped electrons and reflected ions adequately describe the Mach number versus amplitude and light-ion concentration dependence.

1943 Surface wave propagation on the plasma column excited by the ring of magnetic currents. Sharma, S.C.; Verma, J.S. (Birla Inst. of Tech. and Science, Pilani (India). Plasma Research Div.). **15**: No. 3, 214-215(Mar 1977).

Published in summary form only, 6 refs.

1944 Excitation of slow transverse magnetic waves for plasma heating at the lower hybrid frequencies. Baranov, Y.F.; Shcherbinin, O.N. (A. F. Ioffe Physicotechnical Institute, Academy of Sciences of the USSR, Leningrad). **3**: No. 2, 136-141(Mar 1977).

The excitation of slow waves in a plasma is analyzed in the linear approximation. The antenna system consists of an array of waveguides which open at the level of the wall bounding the plasma. The waveguides are oriented in a manner designed to excite an E wave having a singularity at the lower hybrid resonance. The boundary conditions formulated at the plasma surface take into account the nature of the wave propagation in the inhomogeneous plasma at the periphery of the plasma configuration. The reflection coefficients and the spectra of the power absorbed by the plasma are found as functions of the number and size of the waveguides, the plasma properties, and the impedance of the chamber walls. With a large number of waveguides the spectrum of the waves capable of penetrating into the interior of the plasma turns out to be independent of the wall impedance. The optimum spectrum can also be achieved by using only two waveguides, if the metal chamber walls have the appropriate fin configuration.

1945 Design of systems for rf heating at the lower hybrid frequency. Piliya, A.D.; Fedorov, V.I.; Shcherbinin, O.N.; Dyatlov, I. (A. F. Ioffe Physicotechnical Institute, Academy of Sciences of the USSR, Leningrad). **3**: No. 2, 142-145(Mar 1977).

Boundary conditions are discussed for the problem of slow waves launched in an inhomogeneous plasma near the lower hybrid frequency. If the waves are only slightly retarded, and the conditions under which the waves can reach the interior of the plasma are not satisfied, there is a strong coupling of E and H waves, and the boundary conditions at the surface must be described by a matrix. Calculations of the matrix elements and the asymptotic form of the solution are reported.

1946 Self-focusing of an electrostatic drift wave. Petviashvili, V.I. (I. V. Kurchatov Institute of Atomic Energy, Moscow). **3**: No. 2, 150-151(Mar 1977).

Small-amplitude drift waves occur over a comparatively large volume, so that their growth can be suppressed by magnetic shear. When the amplitude of the drift waves is not small, there is a tendency toward compression, or a two-dimensional self-focusing in the plane transverse to the magnetic field. Because of the small volume occupied by these waves, their growth is more difficult to suppress.

1947 Low-frequency waves in an inhomogeneous slab of magnetized plasma. Gradov, O.M.; Izmailov, G.N. **3**: No. 2, 152-153(Mar 1977).

Longwave quasielectrostatic waves of an inhomogeneous magnetized plasma are analyzed for the case of an arbitrary angle between the inhomogeneity gradient and the magnetic field. The frequencies and damping rates of these waves are found.

1948 Formation of fine-scale structure and resonant absorption of electromagnetic waves in a magnetized plasma. Eidman, V.Y. (Scientific-Research Radiophysical Institute, Gor'kii). **3**: No. 2, 190-194(Mar 1977).

The formation of fine-scale structure near the region of a plasma resonance under the influence of an electromagnetic field penetrating into a plasma is analyzed. The electron density is assumed to be a function only of the square amplitude of the electric field, vertical-barEvertical-bar^2. A study is also made of conditions such that the field in the plasma has a configuration similar to that of an ordinary wave. In the linear approximation (vertical-barEvertical-bar^{2}very-much-less-thanE^2/sub cr/, E^2/sub cr/proportionalν/sub ef//ω, where ν/sub ef/ is the effective electron collision rate) there is no interaction with the extraordinary wave, for which there is also a resonance in this case. Under the assumption that the external magnetic field is relatively weak (u=ω^2/sub H//ω^2very-much-less-than1, where ω/sub H/ is the electron gyrofrequency, and ω is the angular frequency of the electromagnetic field) it is shown that the fine-scale structure forms if vertical-barEvertical-bar^2>>E^2/sub cr/. The resulting dissipation of electromagnetic energy is of a universal nature, independent of both ν/sub ef//ω and the particular nature of the nonlinearity.

1949 Second helicon branch in a plasma due to relativistic electron motion and finite wave amplitude. Kotsarenko, N.Y. **3**: No. 2, 197-198(Mar 1977).

For waves of finite amplitude a second helicon branch is shown to arise in a cold electron plasma when the electron motion is relativistic. The phase velocity of the wave is proportional to the square root of the wave amplitude.

1950 Shock waves in arbitrary amplitude in a low-density plasma in a magnetic field. Berezin, Y.A.; Vshivkov, V.A. (Computation Center, Siberian Branch, Academy of Sciences of the USSR, Novosibirsk). **3**: No. 2, 207-210(Mar 1977).

A numerical study is made of shock waves propagating across a magnetic field in a low-density plasma. The ions are described by a kinetic equation, while the electrons are described by gasdynamic equations. Finite conductivity, dispersion, and electron thermal conductivity are taken into account. A study is made of the breaking of supercritical waves, accompanied by the formation of fast particles and a foot on the profile of the magnetic field, with a scale length on the order of the ion gyroradius. The processes which result from the decay of the initial discontinuity of the plasma density and the magnetic field are classified.

1951 Dynamics of strong Langmuir turbulence in a constant pump field. Al'terkop, B.A.; Volokitin, A.S.; Tarakanov, V.P. (Institute of High Temperatures, Academy of Sciences of the USSR). **3**: No. 1, 34-38(Jan 1977).

The nonlinear dynamics of the modulation instability of plasma waves in the field of a constant, coherent pump in the supersonic regime is studied analytically and numerically. The dynamics of both individual soliton and multisoliton configurations is studied. Landau damping of plasma waves by electrons does not stop the increase in the energy of the system, since density perturbations are not stabilized.

1952 Macroscopic instability of magnetosonic solitons. Zelenyi, L.M. (Institute of Cosmic Studies, Academy of Sciences of the USSR). **3**: No. 1, 38-42(Jan 1977).

The large-scale instability of spatially inhomogeneous electron streams flowing across a magnetic field in quasisteady profiles corresponding to collisionless shocks or nonlinear waves is analyzed. The linear theory of the large-scale macroscopic instability of direct magnetosonic solitons is studied in detail. Oblique perturbations of the whistler type should be most important. The perturbation growth rates and wavelengths are found as functions of the Mach number.

1953 Excitation and thermalization of a fast magnetosonic wave near its maximum frequency. Kalinichenko, S.S.; Kurilko, P.I.; Lysoivan, A.I.; Tarasenko, V.F.; Shvets, O.M. (Physicotechnical Institute, Academy of Sciences of the Ukrainian SSR, Khar'kov). **3**: No. 1, 68-71(Jan 1977).

An experimental and theoretical study has been made of the conditions for thermalization of a fast magnetosonic wave in a dense plasma ($n \sim 10^{13}$ cm^{-3}) having toroidal geometry at frequencies near the maximum frequency. When the working frequency of the oscillator lies below the maximum frequency, rf energy can be effectively absorbed due to Cerenkov absorption by plasma electrons. There is also nonlinear absorption of rf energy by electrons and ions near the maximum magnetic field.

1954 Role of rf beam modulation in the formation of a beam-plasma discharge without a magnetic field. Rogashkova, A.I.; Rogashkov, S.A. (Institute of Radio Engineering and Electronics, Academy of Sciences of the USSR). **3**: No. 1, 93-96(Jan 1977).

An approximate nonlinear theory is developed for the interaction of a modulated electron beam with an inhomogeneous plasma in the absence of a magnetic field. An analytic expression is found for the amplitudes of the current harmonics at the modulation and combination frequencies. The rf fields reach breakdown values, so that the region in which the discharge forms can shift.

1955 Degree of linear polarization of the bremsstrahlung from a plasma in a magnetic field. Tuganov, V.F. (Moscow Physicotechnical Institute). **3**: No. 1, 98-100(Jan 1977).

The Born approximation is used to calculate the dependence of the polarization of bremsstrahlung from a monrelativistic plasma on the anisotropy of the electrons.(AIP)

1956 Measurements of electromagnetic field modifications in turbulent plasma. Ghosh, A.K.; Shkarofsky, I.P.; Almey, E.N. (RCA Ltd., Ste-Anne-de-Bellevue, Quebec). **12**: No. 2, 159-170(1977).

An experimental technique is developed to measure the modification of an electric field in a turbulent plasma. The method is

suitable for use up to near critical density of the plasma. Measurements have been performed under three plasma conditions, namely, underdense, intermediate density, and near critical density. The results show more rapid attenuation of the coherent wave than predicted by exponential decrease, which is attributed to refraction in our nonuniform plasma column. The data indicate an initial buildup of the incoherent wave (both direct and cross-polarized components) and then a decrease to a certain level depending on the equivalent thickness as the wave penetrates into the plasma.

1957 Influence of mirror configurations near the lower hybrid resonance. Glomski, G.; Heinrich, B.; Schlueter, H. (Bochum Univ. (Germany, F.R.). Inst. fuer Experimentalphysik 2). **31**: No. 12, 1559-1565(Dec 1976). (In German).

6 figs.; 7 refs.

Hydrogen plasmas in magnetic mirror configurations are generated by microwaves and inductively coupled to a weak rf-source. In contrast to previous investigations of the rf-frequency is varied; resonant behaviour near the lower hybrid frequency is found, attributable to radial eigenmodes. The influence of various mirror ratios and consequently varying axial density gradients on the position of the modes is studied. Shifts of the coupling coil are found to be of minor importance, since the resonant behaviour is dominated by oscillations of the whole plasma body.

1958 Reflection of electromagnetic pulses from a moving inhomogeneous plasma. Rattan, I. (Indian Inst. of Tech., New Delhi. Dept. of Physics). **50**: No. 10, 886-890(Oct 1976).

The problem of reflection of a Gaussian envelope amplitude modulated (AM) pulse from an inhomogeneous plasma, moving uniformly in a direction parellel to the plane of incidence has been analysed. The electron density in the plasma is assumed to vary linearly such that the moving plasma is described by a linearly decreasing specific permittivity profile. Some numerical results have been presented which explicitly show the dependence of amplitude reflection coefficient and the reflected pulse on the velocity of the inhomogeneous plasma and the angle of incidence.

1959 Divergence of a Gaussian laser beam by an inhomogeneous plasma column. Narita, H. (Nara Technical Coll., Yamato-Koriyama (Japan)); Azakami, T. **15**: No. 9, 1703-1708(Sep 1976).

The propagation and refraction of a Gaussian laser beam normally incident upon an inhomogeneous plasma column, in which the electron density distribution is parabolic, are theoretically investigated from the viewpoint of wave-optics. The phase shift and beam radius of the laser beam transmitted through the plasma column are computed at various electron densities. When the cutoff frequency of the plasma is much lower than the frequency of incident laser rays, the phase shift obtained analytically in this paper shows a good agreement with that from the WKB approximation.

1960 Alfven soliton. Mikhailovskii, A.B.; Petviashvili, V.I.; Fridman, A.M. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). **24**: No. 2, 53-56(20 Jul 1976). (In Russian).

Letter-to-the-editor; for English translation see the journal JETP Lett.

1961 Symbolic computation of nonlinear wave interactions on MACSYMA. Bers, A.; Kulp. J.L.; Karney, C.F.F. (Massachusetts Inst. of Tech., Cambridge). **12**: 81-98(1976).

The use of a large symbolic computation system--MACSYMA--in determining approximate analytic expressions for the nonlinear coupling of waves in an anisotropic plasma is described. MACSYMA was used to implement the solutions of a fluid plasma model nonlinear partial differential equations by perturbation expansions and subsequent iterative analytic computations. By interacting with the details of the symbolic computation, the physical processes responsible for particular nonlinear wave interactions could be uncovered and appropriate approximations introduced so as to simplify the final analytic result. Details of the MACSYMA system and its use are discussed and illustrated.

FUSION POWER PLANTS

1962 (PPPL-Q—34) Annual report, July 1, 1975—September 30, 1976. 1976. Contract EY-76-C-02-3073. 186p. Dep. NTIS, PC A09/MF A01.

This annual report gives brief descriptions of each of the following projects: (1) PLT, (2) PDX, (3) TFTR, (4) driven tokamak plasmas, (5) FM-1, (6) ATC, (7) linear devices, (8) reactor studies, (9) theory, (10) library, (11) planning, (12) utilities, (13) administration, (14) engineering, (15) machine design and fabrication, (16) graduate education, and (17) statistics. (MOW)

1963 (UCRL—79641) Prospects for a DD tandem mirror. Logan, B.G. 20 Jun 1977. Contract W-7405-ENG-48. 13p. (CONF-770644—7). Dep. NTIS, PC A02/MF A01.

From EPRI review meeting on advanced fuel fusion; Chicago, Illinois, United States of America (USA) (27 Jun 1977).

The possibility of burning advanced fusion fuels in a tandem mirror is considered for a catalyzed DD cycle, in which the T and ^{3}He reaction products from DD burn in both the solenoid and plugs are reinjected for complete burnup: $3D \rightarrow p + {}^4He + n + 21.6$ MeV. Classical radial transport of the ^{4}He ash determines the steady state alpha fraction in the solenoid. Synchrotron radiation losses are minimized at high beta, such that charged particle fusion power recovered in a direct converter exceeds radiation losses by a factor greater than two. An overall system $Q = 4.5$ is found for one reaction example but the power output is large (3 GE(e) net) due to the low power density in the solenoid. Optimizing recirculating power cost (Q) against plug/solenoid density ratio (power density) should result in much smaller reactor size and cost.

1964 Steady-state reactor with neoclassical pits. Comucci, C.; Tessarotto, M. (Trieste Univ. (Italy)). **17**: No. 7, 225-230(16 Oct 1976).

A theoretical model for steady state D-T toroidal reactor is presented assuming that transport properties are neoclassical, i.e. no anomalous transport is present in that a stable magnetic configuration can be mantained in the plasma. Using an asymptotic ordering in terms of the ratio between particle Larmor radius and the scale length characteristic for spatial variation of equilibrium, all the meaningful quantities are developed in power series. The relevant equations, e.g. Fokker-Plank and Poisson equations, are then solved by series expansion in terms of this parameter. Assuming that sources (of alpha particles as well of plasma-ions and electrons) are isotropic in velocity space the possibility that they can balance the losses due to nonclassical transport are discussed. Using a simple model for the nonclassical pit we give an estimate for the neoclassical confinement times and for the power density transferred from alpha particles to electrons and (D,T) ions via collisional processes.

1965 Kakuyugo kenkyu no shinpo to doryokuro kaihatsu e no tenbo. (Progress of nuclear fusion research and review on development of fusion reactors). Tokyo, Japan; Atomic Energy Society of Japan (1976). 575p. (In Japanese).

Set up in October 1971, the ad hoc Committee on Survey of Nuclear Fusion Reactors has worked on overall fusion reactor aspects and definition of the future problems under four working groups of core, nuclear heat, materials and system. The presect volume is intended to provide reference materials in the field of fusion reactor engineering, prepared by members of the committee. Contents are broadly the following: concept of the nuclear fusion reactor, fusion core engineering, fusion reactor blanket engineering, fusion reactor materials engineering, and system problems in development of fusion reactors.

1966 Current state and prospects for development of controlled thermonuclear fusion. Velikhov, E.P. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii); Kintner, E.E. (Energy Research and Development Administration, Washington, D.C. (USA)). **14**: No. 4, 719-733(1976).

The benefits of fusion power are discussed. The principal recent achievements in plasma heating and confinement are summarized. Problems of compression processes and technology development related to inertial confinement techniques are discussed. Lasers with power of 10^{12}W, energies of several hundred joules and impulse times of 10^{-10} to 10^{-9} have been developed in addition to advances in diagnostics and target fabrication. Recent experiments are reported that confirm the main principles of electron beam compression. Results of investigations into the magnetic compression of plasma targets indicate that a proof-of-principle experiment can soon be performed. The authors review problems and recent advances in fusion technology of heating systems, superconducting magnets, materials, vacuum pumps, fuelling and feedback control, laser and electron beam development, power sources, and target manufacture. The lack of 14 MeV neutron sources is identified as an important obstacle to materials development. Experimental devices under construction are discussed and the larger tokamaks being designed to produce substantial thermal energy and study reactor-level deuterium-tritium plasmas are described. Finally, the outlines of conceptual designs for prototype experimental power reactors and demonstration power reactors are treated briefly.

PHYSICS AND BLANKET ENGINEERING

REFER ALSO TO CITATION(S) 1991

1967 (AD-A—039815) A simple model of a LINUS fusion system with a thick, compressible, resistive liner. Interim report. Robson, A.E. Apr 1977. 31p. (NRL-MR—3472). NTIS PC A03/MF A01.

A simple model is developed to describe the compression of a plasma to high density and fusion temperature by a thick, compressible imploding liner. In contrast to previous thin liner calculations, the dwell time around peak compression is now less than the transit time of a sound wave through the liner, and thus only the inner part of the liner contributes to the inertial confinement of the plasma. The model first derives the size of the active part of the liner, and goes on to determine the final conditions (pressure, radius, etc.,) achieved by the compressible liner in terms of the same quantities derived from the incompressible model used previously. The effect of resistive diffusion of magnetic field into the inside surface of the liner is treated as a perturbation. Finally, the results of the model are used to determine the working point of a LINUS reactor. (Author)

1968 (COO—2711-3) **EUV impurity study of the Alcator tokamak.** Terry, J.L.; Chen, K.I.; Moos, H.W.; Marmar, E.S. Jun 1977. Contract EY-76-S-02-2711. 63p. Dep. NTIS, PC A04/MF A01.

The intensity of resonance line radiation from oxygen, nitrogen, carbon and molybdenum impurities has been measured in the high field (80 kG), high density ($6 \times 10^{14} cm^{-3}$) discharges of the Alcator tokamak, using a 0.4 m normal incidence monochromator (300 to 1300 A) with its line of sight fixed along a major radius. The total light impurity concentrations were 2×10^{-3}, 7×10^{-4}, and 3×10^{-3} at central electron densities of $4.5 \times 10^{13} cm^{-3}$ (burnout), 4.0×10^{13} (low density plateau) and 6.0×10^{14} (high density plateau). Both a simple model and a computer code which included Pfirsch-Schluter impurity diffusion were used to estimate oxygen influxes of $1.6 \times 10^{13} cm^{-2} sec^{-1}$ and $1.5 \times 10^{14} cm^{-2} sec^{-1}$ at the plasma edge in the low and high density emission plateaus. The resulting values of Z/sub eff/, including the contributions due to both the light impurities and molybdenum, were close to one. The power lost through the impurity line radiation accounted for approximately equal to 7 percent of the total ohmic input power at high densities.

1969 (GA-A—14412) **TNS scoping studies. Interim status report for the first half of FY-77, October 1, 1976—March 31, 1977.** May 1977. Contract EY-76-C-03-0167-038;W-31-109-ENG-38. vp. Dep. NTIS, PC A15/MF A01.

Scoping studies were performed of the major components and subsystems of the 3.8 m ITR. Alternative design concepts were identified, developed, and evaluated. In some cases, tentative designs were selected. For the toroidal field coils, for example, NbTi superconducting coils with maximum field capability of 10 tesla were selected. The characteristics for both neutral beams and rf systems for plasma auxiliary heating were developed. Several design concepts for the plasma chamber vacuum pumping system were considered, and the cryosorption system was tentatively selected for the ITR. A tritium handling system, employing a cryo-chemical purification system, was developed in substantial detail. In addition, the initial conceptual design of the power supplies for the E-coil was developed and an initial assessment was made of the materials options for the critical components. Estimates of the plasma beta together with a variety of models of the transport and radiative losses are used to size the device and to determine the necessary auxiliary heating power. Alternative heating scenarios are compared on the basis of the spatial deposition of the particle and energy sources. Plasma initiation and the early time behavior of the discharge are examined with special attention to the atomic and molecular physics of breakdown and the radiative losses associated with non-equilibrium impurity distributions. Results from the engineering design, support systems considerations and physics studies have been evaluated in terms of a preliminary R and D assessment. The assessment allows for the identification and selection of design criteria and options on the basis of R and D involvement and subsequent costs. A preliminary R and D plan formalism has been developed and integrated into a functional design sequence scenario.

1970 Petula tokamak experiment: effects of low-Z materials on plasma characteristics. Bardet, R.; Bernard, M.; Briffod, G. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Grenoble, 38 (France). Service Ionique Generale) (and others). pp 259-266 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R (6 - 13 Oct 1976).

Alumina and carbon limiters have been used in Petula. Compared to discharges produced with a tungsten limiter, discharges with alumina limiter show better plasma characteristics: the concentration of oxygen, which is the dominant impurity in both cases, decreases by a large factor, as does the plasma resistivity at the same electron temperature. As a result, the gross confinement time increases significantly, which is thought to be due to smaller line radiation losses. The important part played by the limiter in oxygen contamination is clearly due to these results and, from this point of view, alumina is much better than tungsten. On the other hand, the poor ability of alumina to resist thermal stresses is a severe limitation to its practical use. In the cae of a carbon limiter, which does not suffer from this drawback, the amount of carbon released into the plasma is too high to provide stable discharges. The strong correlations observed between displacement, voltage fluctuation and C IV line emission suggests that feedback control stabilization and better-quality pyrocarbon could improve the plasma characteristics.

1971 Application of the collisional transport model to the cold-plasma blanket problem. Engelmann, F.; Schrijver, H. (Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Instituut voor Plasma-Fysica); Nocentini, A. (Trieste Univ. (Italy)). pp 19-26 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R. (6 - 13 Oct 1976).

For the cold-plasma blanket to be a useful refuelling device, appropriate steady states of the plasma on a time scale larger than the particle confinement time must exist. These steady states are investigated for a plasma without and with impurity content, adopting the collisional transport model. It is found that the steady-state solutions indeed show the appearance of a cool and dense blanket and that no important accumulation of impurities at the discharge centre occurs for them.

1972 DIVA divertor and JFT-2 confinement experiments. Maeda, H.; Fujisawa, N.; Shimomura, Y. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment) (and others). pp 289-299 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R (6 - 13 Oct 1976).

This paper describes DIVA divertor and JFT-2 confinement experiments. DIVA is a tokamak with an axisymmetric divertor with typical plasma current of 15kA, electron temperature of about 200eV, and ion temperature of 50-100eV. A qualitative investigation of the cause of contamination of the plasma by heavy elements was performed. In JFT-2 confinement studies were concentrated on the behaviour of impurities at a toroidal field of 18kG. Spectroscopic measurements indicate that the main impurity is oxygen, whose radial profiles are measured up to O-VIII.

1973 Neutrals and impurities in the tokamak discharges. Mercier, C.; Werkoff, F. (Association Euratom-CEA sur la Fusion, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). pp 29-42 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R. (6 - 13 Oct 1976).

This paper is devoted to particular and detailed studies with the Fontenay-aux-Roses one-dimensional toroidal transport code. In Section 2, the distribution of the neutrals inside the plasma and the following subsequent points are discussed: a) the correction to be added to the value of Tsub(i) obtained by analysing the spectrum of the outgoing neutrals created inside the plasma by charge exchange; b) the flux for a given energy and per unit of surface of the neutrals striking the walls. In Section 3 the influence of some parameters on the accumulation of the impurities is studied. Also the effects of the friction between two species of impurity (oxygen and molybdenum) in the case of the injection of a puff of oxygen are studied. Finally, in Section 4, sawtooth oscillations are simulated in order to attempt to shed some light on this phenomenon.

1974 Divertor and injection experiments in DITE tokamak. Paul, J.W.M.; Axon, K.B.; Burt, J. (UKAEA Research Group, Abingdon. Culham Lab.) (and others). pp 269-285 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R (6 - 13 Oct 1976).

The modes of operation of the tokamak are described including the effect of inserting a small limiter into the plasma. The ion temperature has been doubled by injecting 200kW of neutral beams into the plasma. The unique bundle divertor has transferred more than half of the power loading from the torus wall to the divertor target. This device is shown to be a powerful tool for controlling and studying plasma-wall interactions.

1975 Evolution of the densities of several impurity species simultaneously present in tokamak-like plasmas. Sardei, F.; Duechs, D.F. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). pp 43-53 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R. (6 - 13 Oct 1976).

The simultaneous diffusion of several (at present up to six) optional ion species is numerically investigated on the basis of unabridged available theories. Ionization and recombination processes are taken into account as well. Special consideration is given to a combination of heavy (Fe) and light (O) impurity ions in a hydrogen plasma. The effect of (normal and anomalously enhanced) electron collisions on the evolution of the ion profiles is checked. The composition of the plasma is cruicially determined by the initial distribution of heavy impurities; mostly, H is pushed out. Reduction of heavy impurities by the influx of light species seems possible. The applicability of the simpler corona equilibrium formulas for the distribution of the stages of ionization is restricted to a narrower domain.

1976 Nuclear fusion equipment. Nishi, M.; Wase, K. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-94,096/A/. 14 Feb 1975. 3p. (In Japanese).

Object: To alleviate the temperature rise of a limiter due to heat introduced from the plasma. Structure: Plasma is supported by a coil within a vacuum container and a liner and limiter are disposed between the plasma and container. A heat conduction member is provided outside the liner and at a position to face the limiter.

1977 Composition profiles of several contaminated and cleaned surfaces of gold thick films on copper plates by Auger electron and secondary ion mass spectroscopies. Komiya, S.; Mizuno, M.; Narusawa, T. (Ulvac Corp., Chigasaki, Kanagawa (Japan)); Maeda, H.; Yoshikawa, M. No. Suppl. 2-1, 363-366(1974).

From 6. international vacuum congress; Kyoto, Japan (25 Mar 1974).

Preparation and evaluation of a clean Au film are investigated. Development of a preparation method for obtaining clean surface on a copper shell in the JFT-2a (DIVA) TOKAMAK toroidal vacuum chamber is the aim of the present work. Au films prepared by ion plating and vacuum evaporation have been analysed by a cylindrical mirror Auger electron analyser in combination with a quadrupole mass spectrometer during 2 keV Xe ion bombardment from a sputter ion gun over the whole range of thickness of several microns. Contaminants are found to segregate on the top surface and at the interface. To expose a clean Au surface by the ion bombardment, surface layers within 1000 A had to be removed from the surfaces contaminated by touching with either a naked hand or a nylon glove or covered by a small amount of Ti. Mutual diffusions across the interfaces are also analyzed as a function of the substrate temperature. A Nb sandwich layer inhibites effectively the mutual diffusion.

MAGNET COILS AND FIELDS

1978 (CONF-770801—17) **Superconductors for tokamak poloidal field coils.** Schwall, R.E.; Shen, S.S.; Dresner, L.; Lue, J.W.; Miller, J.R.; Yeh, H.T. 1977. Contract W-7405-ENG-26. 10p. Dep. NTIS, PC A02/MF A01.

From Cryogenic engineering conference; Boulder, Colorado, United States of America (USA) (2 Aug 1977).

The a.c. losses and stability of a number of model conductors for tokamak poloidal field coils have been evaluated. The conductors employ mixed matrix NbTi superconductor cabled with copper stabilizer and were tested with insulated strands, bare strands and solder filled. Data are presented for total loss per cycle as a function of maximum field and of field sweep rate. These losses are separated into filament hysteresis loss, filament coupling loss, stabilizing strand eddy loss and interstrand coupling loss. The data are compared with the predictions of a new theory which models the conductor as a LR circuit closely coupled to the magnet. Data are also presented for the velocity of propagation or recovery of a normal zone, the full recovery current and the minimum propagating current. The dependence of stability on the degree of coupling between the strands and on the amount of helium present in the cable is also discussed.

1979 (CONF-770842—4) **Toroidal magnet system conceptual design for the ELMO Bumpy Torus Reactor.** Luton, J.N. Jr.; Yeh, H.T. 1977. Contract W-7405-ENG-26. 5p. Dep. NTIS, PC A02/MF A01.

From 6. international conference on magnet technology; Bratislava, Czechoslovakia (29 Aug 1977).

The ELMO Bumpy Torus Reactor (EBTR) is a fusion reactor device based on the concept of toroidally linked mirrors. To minimize engineering uncertainties, the EBTR superconducting magnet system is designed so that it could be built with existing or near-term technology. The design uses identical coils in standard modules, thus facilitating commercialization. The reference design uses 48 modules and produces 4000 MW(th).

1980 (CONF-770842—5) **Design of superconducting toroidal magnet coils and testing facility in the USA.** Luton, J.N.; Haubenreich, P.N.; Thompson, P.B. 1977. Contract W-7405-ENG-26. 6p. Dep. NTIS, PC A02/MF A01.

From 6. international conference on magnet technology; Bratislava, Czechoslovakia (29 Aug 1977).

In the U.S. Large Coil Program, three industrial teams are presently designing test coils to general specifications prepared by the Oak Ridge National Laboratory with guidance from USERDA. Each test coil is approximately half the bore size of reactor coils, being oval or D-shaped, with a bore of 2.5 x 3.5 m. The dimensions and operating requirements of the coils are identical for all test coils. The coils are designed to produce a peak field of at least 8 tesla at the winding of a selected coil operated at its design current. This condition is met when the selected coil is operated in a compact toroidal array of 6 coils, with the other five coils being operated at 0.8 of their design current. The six coils are of three different designs. Both pool boiling and forced flow designs are included. The coils are housed in a single large vacuum chamber for economy and testing convenience. Auxiliary coils provide a pulse field over the test coil winding volume. This auxiliary system is designed to produce a pulse field which rises to a peak of 0.14 T in 1 sec. With the exception of material damage due to neutron irradiation, all reactor requirements and environments will be either duplicated, approximated, or simulated. The test facility is being designed to accept coils producing up to 12 tesla in later phases of the program.

1981 (UCRL—78890) **Mechanical strain of large, multifilament Nb_3Sn conductors for fusion magnets.** Deis, D.W.; Cornish, D.N.; Rosdahl, A.R.; Hirzel, D.G. 1 Aug 1977. Contract W-7405-ENG-48. 6p. (CONF-770842—7). Dep. NTIS, PC A02/MF A01.

From 6. international conference on magnet technology; Bratislava, Czechoslovakia (29 Aug 1977).

The effects of mechanical strain on the high-field critical current, I/sub c/, of two Nb_3Sn conductors were measured. Static strains up to 0.9 percent and cyclic strains to 0.6 percent were used; I/sub c/ was measured at fields up to 12 T. Critical current, which increased with strain in all cases, peaked at approximately 0.3 percent and decreased for higher strains. For strains less than 0.8 percent, the change in I/sub c/ was reversible; permanent damage only occurred in one conductor for strains near 0.9 percent. No effect of cyclic strains, 0.6 percent in amplitude, could be detected up to 500 cycles.

1982 (UCRL—78891) **Development work on superconducting coils for a large mirror fusion test facility (MFTF).** Cornish, D.N.; Deis, D.W.; Harvey, A.R.; Hirzel, D.G.; Johnston, J.E.; Leber, R.L.; Nelson, R.L.; Zbasnik, J.P. 27 Jul 1977. Contract W-7405-ENG-48. 7p. (CONF-770842—1). Dep. NTIS, PC A02/MF A01.

From 6. international conference on magnet technology; Bratislava, Czechoslovakia (29 Aug 1977).

The geometry and size of the superconducting coils for the Mirror Fusion Test Facility (MFTF) proposed by Lawrence Livermore Laboratory (LLL) impose certain constraints on the Nb-Ti superconductor. The most promising fabrication process is a wrap-around technique in which a superconducting core is "wrapped" in stabilizing copper that contains built-in cooling channels. Insulation between pancake coils and turns is provided by perforated sheets and buttons of epoxy-impregnated fiberglass. Preliminary heat-transfer tests conducted on short samples of single conductor and on a nine-conductor bundle are reported and related to the heat generated in "normal" conductors. Investigation of joining techniques, necessary because of the length of conductor needed for the MFTF magnet (about 21 km per coil), show that cold-welded butt joints best meet all requirements. In a test coil now being built, approximately 2 km of prototype MFTF conductor will provide a self-field of about 4 T. Supplementary coils will boost the field to about 6.7 T. The test coils will be used to study cryostatic stability, the propagation and recovery of normal zones, and diagnostic techniques.

1983 Formation and evolution of magnetic islands in a tokamak plasma. Danilov, A.F.; Dnestrovskii, Y.N.; Kostomarov, D.P.; Popov, A.M. (I. V. Kurchatov Institute of Atomic Energy, Moscow). 3: No. 2, 117-120(Mar 1977).

The plasma motion in a tokamak is studied through a numerical solution of the two-dimensional MHD equations with a finite conductivity. For the case of the m=2 kink mode, the formation and evolution of magnetic islands are studied. If the current profile in the plasma is sharp, the islands cannot reach the center of the plasma; instead, they diffuse toward the periphery. When the islands reach the surface, plasma escapes to the limiter and to the chamber walls.

1984 Tokamak plasma magnetics. Callen, J.D.; Clarke, J.F.; Dory, R.A. (Oak Ridge National Lab., Tenn. (USA)) (and others). pp 369-384 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R (6 - 13 Oct 1976).

High-β (approximately 5-30%) tokamak equilibria have been found and the external magnetic field structures required to attain and hold them have been studied. The high-β equilibria can be a natural consequence of intense heating by an auxiliary power source

such as neutral beams, if the heating is rapid compared to the magnetic diffusion time scale. Since magnetic fluxes are "frozen in" for such equilibria, they are called flux-conserving-tokamak (FCT) equilibria. FCT equilibria are shown to exist and satisfy the local (Mercier) stability criterion with β-values ranging up to 28%. For slighly D-shaped cross-sections, simple and efficient poloidal field systems are described which properly control and shape the plasma and admit poloidal divertors at the apexes of the natural D-shaped cross-sections. The poloidal field system may also have the property (STATIC concept) of shielding (by a factor of about 6) superconducting toroidal field coils from flux changes. Finally, the toroidal field ripple effects that enhance the ion heat conduction and cause a substantial fraction of alpha particles to drift out of the plasma are briefly discussed.

1985 Spectroscopic observation of fluctuating fields in a theta pinch plasma with no bias field. Oda, T.; Kawasaki, K.; Ohgo, T.; Ichinose, K.; Takeyama, H. (Hiroshima Univ. (Japan). Faculty of Science). **15**: No. 11, 2251-2252(Nov 1976).

Published in summary form only.

1986 Model experiment on quasi-stationary vertical magnetic field in a tokamak type apparatus. Sometani, T. (Shizuoka Univ., Hamamatsu (Japan). Faculty of Engineering); Matsuoka, K.; Fujiwara, M.; Itoh, S. **15**: No. 8, 1543-1548(Aug 1976).

An experiment with a model device of the JIPP T-II apparatus, a hybrid apparatus between Tokamak and Stellarator, is carried out in order to investigate various factors altering the decay index due to the current of a winding for the D.C. vertical magnetic field (designed index). The image current in an iron core of the current of the winding makes worse the designed index. However, the added contribution of a primary current, its image, and the image of a plasma current in the iron core alters the designed index favourably. The effect of the excitationof the iron core is negligible. The distribution of the resultant decay index in the real apparatus is expected to be improved satisfactorily by the added contribution.

1987 Electromagnetic coil partly disposed in a narrow space. Hashimoto, H.; Ito, Y. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-92,998/A/. 12 Feb 1975. 5p. (In Japanese).

Object: To provide an electromagnetic coil which is used for nuclear fusion equipment and permits simplification of the operation of inter-coil insulation and connection while improving operability. Structure: A coil is disposed in or near a narrow space and brought near the ground side of a power source thereby permitting reduction of insulation strength to obtain desired effects.

1988 Coil frame for nuclear fusion apparatus. Uchida, T.; Kitamura, K.; Fukushima, H. (to Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). Japanese Patent 1976-92,999/A/. 12 Feb 1975. 3p. (In Japanese).

Object: To provide a coil frame which is superior in mechanical strength and provides high magnetic flux permeability with respect to plasma. Structure: A ring having a very thin wall thickness is formed a material having a high mechanical strength, and a coil securing member of a material exhibiting a low magnetic permeability is provided on the surface of the ring at a portion thereof where the coil is not wound.

COOLING SYSTEMS

1989 Toroidal nuclear fusion equipment. Kurita, I.; Tateishi, S. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-94,097/A/. 14 Feb 1975. 3p. (In Japanese).

Object: To effectively cool the outer periphery of the vacuum container. Structure: A cooling pipe is wound on the outer periphery of a vacuum container capable of containing plasma and is urged against the outer periphery of the container by using an elastic member. With this arrangement, even if the vacuum container is deformed due to thermal expansion or contraction, the cooling pipe can be held in close contact with the outer periphery of the vacuum container to permit effective cooling of the vacuum container.

FUEL SYSTEMS

REFER ALSO TO CITATION(S) 1602, 1997, 1998, 1999

1990 (AD-A—039844) **Compression by liners of plasma-field configurations with beta < 1.** Robson, A.E. Apr 1977. 18p. (NRL-MR—3484). NTIS PC A02/MF A01.

This report derives the thermonuclear yield from a cylindrical plasma with beta < 1 (specifically, a reversed-field theta-pinch configuration) being compressed by an imploding liner. Since magnetic field is mixed with plasma, the average plasma density, and hence the fusion output are reduced in comparison with the beta = 1 systems considered previously. The trajectory of the liner is also modified due to the increased gamma (ratio of specific heats) of the plasma-field mixture. For the same peak field and system size, the value of Q (ratio of fusion output to system energy) is reduced to a fraction s of its value in the beta = 1 case, where s depends upon the initial pressure distribution in the plasma, and upon the compression ratio; over the likely range of parameters, $0.1 < s < 0.3$. The significance of this result for the design of LINUS fusion systems is discussed. (Author)

1991 (BNWL—2097(Add.)) **Tritium production from ceramic targets: a summary of the Hanford coproduct program. Addendum: bibliography.** Johnson, A.B. Jr.; Kabele, T.J.; Gurwell, W.E. Jul 1977. Contract EY-76-C-06-1830. 10p. Dep. NTIS, PC A02/MF A01.

This bibliography contains all of the relevant references, alphabetized by author, from those documents reviewed for the Hanford Coproduct Program Summary.

1992 (UCID—17537) **MPD streaming plasma source for MFTF.** Poulsen, P. Jul 1977. Contract W-7405-ENG-48. 24p. Dep. NTIS, PC A02/MF A01.

The applicability of Magneto-plasma-dynamic (MPD) arcs as a source of warm, streaming plasma for start-up and for the suppression of instabilities is discussed. The plasma source emits a high particle flux (1000-5000 amp) of well directed ions having kinetic energy in the 10-100 eV range. The construction details of an MPD plasma source are given and a sequence of proposed tests are presented. The tests are designed to demonstrate the large flux and good gas utilization of the source as well as investigate the behavior of the streaming plasma in a high magnetic field environment.

1993 Ion-acceleration regimes in plasma accelerators. Zharinov, A.V.; Popov, Y.S. (V. I. Lenin All-Union Electrotechnical Institute). **3**: No. 2, 213-216(Mar 1977).

Various regimes of ion acceleration in plasma acclerators, corresponding to different values of ω/sub e H/tau, are studied. The analysis is based on the equation of motion of the ions in the plasma; the interaction of ions with electrons is taken into account. Three ion-acceleration regimes can be distinguished at different values of ω/sub e H/tau: an aperiodic dissipative regime (ω/sub e H/tauvery-much-less-than1), an extreme dissipative regime (ω/sub e H/tau$\sim$1), and a dissipationless regime (ω/sub e H/tau$>>$1). From the physical standpoint, the preferred accelerator is a shortened dissipationless Hall-current ion accelerator in which the ion energy is governed solely by the potential difference applied to the accelerator.

RADIATION HAZARDS

1994 (EPRI-ER—469(Pt.A)) **Evaluations of fusion-fission (hybrid) concepts: market penetration analysis for fusion-fission hybrids. Part A.** Engel, R.L.; Deonigi, D.E. Jan 1976. 36p. Dep. NTIS, PC A03/MF A01.

This report summarizes findings of the fusion-fission studies conducted for the Electric Power Research Institute by Battelle, Pacific Northwest Laboratories. This particular study focused on the evaluation of fissile material producing hybrids. Technical results of the evaluation of actinide burning are presented in a companion volume, Part B.

1995 (EPRI-ER—469(Pt.B)) **Evaluations of fusion-fission (hybrid) concepts: transmutation of high-level actinide waste in hybrids. Part B.** Jenquin, U.P.; Leonard, B.R. Jr. Jun 1976. 60p. Dep. NTIS, PC A04/MF A01.

This report summarizes the findings of the fusion-fission studies conducted for the Electric Power Research Institute by Battelle, Pacific Northwest Laboratories. This particular study focused on the evaluation of actinide burning. Detailed results of an evaluation of fissile material producing hybrids are presented in a companion volume, Part A.

INERTIAL CONFINEMENT SYSTEMS

REFER ALSO TO CITATION(S) 1279, 1283, 1295, 1834

1996 (LA—6827-MS) **One-dimensional computer simulations of the implosion of simple-shell targets with the Los Alamos two-beam CO_2 laser. Series 1.** Cranfill, C.W. Jun 1977. Contract W-7405-ENG-36. 10p. Dep. NTIS, PC A02/MF A01.

This report summarizes the results of a series of one-dimensional computer simulations of the implosion of spherical targets with the Los Alamos two-beam CO_2 laser. The simulations were done with a Los Alamos version of the laser-fusion code LASNEX originally developed at the Lawrence Livermore Laboratory. The targets studied were simple glass microshells filled with DT gas, and the predicted scaling of neutron and X-ray emissions with variations in target and laser parameters was determined for comparison with experiments currently underway at Los Alamos.

1997 (LA-UR—77-1523) **Development of cryogenic targets for laser fusion.** Grilly, E.R. 1977. Contract W-7405-ENG-36. 13p. (CONF-770801—19). Dep. NTIS, PC A02/MF A01.

From Cryogenic engineering conference; Boulder, Colorado, United States of America (USA) (2 Aug 1977).

The best method of cooling D-T to get the condensate into a uniform spherical layer seems to be through a high conductance fiber. One end of this is cemented to the bottom of the microballoon container and the other end kept at 2 to 10 K above the freezing temperature. Future tests will be made with thin fibers of various materials in order to minimize mass.

1998 (UCRL—13735-1) **Deformation of liquid droplets and gas bubbles in electric fields. Research report No. 1.** Jones, T.B.; McCarthy, M.J. May 1976. Contract W-7405-ENG-48-8962605. 15p. Dep. NTIS, PC A02/MF A01.

The behavior of dielectric droplets and gas bubbles in electrostatic levitation, positioning, and control devices for laser-fusion target applications is studied. Because of the exacting tolerance requirements for the sphericity of laser fusion targets, there is concern over the electric field induced elongation effect which may exist in some or all of these schemes. These proposed tolerances suggest upper limits on the axis ratio γ: $\gamma - 1 < 10^{-3}$, which may severely limit the maximum allowable electric field in certain electrostatic levitation schemes. Calculations of the deformation of bubbles in cryogenic hydrogen were undertaken by Bliss, but only for large deformations up to γ approximately 2. These calculations are extended down to very small deformations, that is: $10^{-4} < \gamma - 1 < 10^{-1}$, for droplets of cryogenic liquid hydrogen ($n - H_2$) and bubbles in liquid hydrogen at its triple point. Also, the effect of pressure on the deformation has been explored. Further, approximate explicit analytic expressions for $\gamma(E)$ have been obtained for the limit of small deformations.

1999 (UCRL—13735-3) **Dynamic levitation of charged liquid droplets.** Jones, T.B.; McCarthy, M.J. Jul 1976. Contract W-7405-ENG-48. 33p. Dep. NTIS, PC A03/MF A01.

The influences of static elongation and charged droplet stability on electrostatic dynamic stabilization and levitation are explored. Based on this analysis, the feasibility of levitating charged droplets of low surface tension liquids such as cryogenic hydrogen for laser fusion target research and fabrication is examined.

2000 **High-temperature high-quality deuterium plasma production by laser beam(s) and interactions with magnetic fields.** Sato, K.N. (Nagoya Univ. (Japan). Inst. of Plasma Physics); Okada, S.; Sudo, S.; Sekiguchi, T. (Tokyo Univ. (Japan). Dept. of Physics); Kogoshi, S.; Tsuji, H.; Ohwadano, Y.; Katsurai, M.; Tanaka, H. (Dept. of Electrical Engineering, Tokyo Univ., Japan). pp 567-575 of In Plasma physics and controlled nuclear fusion research 1976. Vol. II. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R. (6 - 13 Oct 1976).

A new system for directly producing impurity-free, high-temperature deuterium plasmas with any type of magnetic containers has been constructed and operated, in which an on-line computer control technique is utilized to capture a failing deuterium ice-pellet by pulsed laser beam(s). Some experimental results on the fundamental physical properties of the plasma produced and interactions with nearly uniform magnetic field are presented. As an immediate application of this particular new plasma production method, detailed studies of spindle-cusp confinement properties for laser-produced high-beta deuterium plasma are being continued. Some of the computer analyses for these problems are also reviewed.

2001 **Isolated deuterium plasma production by laser beam through on-line computer control technique.** Sato, K. (Nagoya Univ. (Japan). Inst. of Plasma Physics); Okada, S.; Kogoshi, S.; Sekiguchi, T. **4**: No. 2, 132-138(Sep 1976). (In Japanese).

A new system for directly producing impurity-free high-temperature deuterium plasmas within any type of magnetic containers has been constructed and operated, in which an on-line computer control technique is utilized to capture a falling deuterium ice-pellet by pulsed laser beam. Some experimental results on the fundamental properties of plasmas produced are presented.

2002 **Optics for laser fusion.** Glass, A.J. (Lawrence Livermore Lab, Calif). **2**: No. 1, 35-39(Jan 1976).

Fusion-laser design involves far more than simply staging amplifiers to achieve the desired gain. It involves a full understanding of the propagation of light at high intensity and of laser-damage phenomena, and an abiding appreciation of the difficulties of fabrication of large-aperture optics for use at high power levels. The ultimate requirement of a fusion laser is that the energy be focusable on a fusion target, which is generally of the order of 100 mum in diameter. This article surveys the problems encountered in developing optics for laser fusion. Specific topics include whole-beam self-focusing, spatial filtering, and aspheric optics. 7 refs.

COMPONENT DEVELOPMENT AND TESTING

REFER ALSO TO CITATION(S) 1146, 1159

2003 (ANL—76-133) **Tritium processing and containment technology for fusion reactors. Annual report, July 1975—June 1976.** Maroni, V.A.; Calaway, W.F.; Misra, B.; Van Deventer, E.H.; Weston, J.R.; Yonco, R.M.; Cafasso, F.A.; Burris, L. 1976. Contract W-31-109-ENG-38. 48p. Dep. NTIS, PC A03/MF A01.

The hydrogen permeabilities of selected metals, alloys, and multiplex preparations that are of interest to fusion reactor technology are being characterized. A high-vacuum hydrogen-permeation apparatus has been constructed for this purpose. A program of studies has been initiated to develop design details for the tritium-handling systems of near-term fusion reactors. This program has resulted in a better definition of reactor-fuel-cycle and enrichment requirements and has helped to identify major research and development problems in the tritium-handling area. The design and construction of a 50-gallon lithium-processing test loop (LPTL) is well under way. Studies in support of this project are providing important guidance in the selection of hardware for the LPTL and in the design of a molten-salt processing test section.

2004 (CONF-770908—4) **Cryosorption vacuum pumping under fusion reactor conditions.** Watson, J.S.; Fisher, P.W. 1977. Contract W-7405-ENG-26. 5p. Dep. NTIS, PC A02/MF A01.

From 7. international Vac. congress and 3. international conference on solid surfaces; Vienna, Austria (12 Sep 1977).

Experiments are in progress on cryosorption pumping using a double-chevron pump with a molecular sieve pumping surface. Studies have been made with hydrogen, deuterium, helium, and deuterium-helium at 10^{-7} to 3×10^{-3} torr. Steady pumping speeds were observed for deuterium; above 10^{-4} torr the speed increased with pressure until runaway occurred. At less than 10^{-6} torr and low panel loading, hydrogen pumping speeds resemble those for deuterium. At higher pressures, the pump can function by condensation or sorption, and unsteady speeds are observed. Helium pumping is always by sorption, but regions of instability have been observed and defined. Deuterium-helium pumping tests showed that deuterium condensation on the panels prevents cryosorption of helium; however, compound pumps with separate panels for helium and hydrogen will be satisfactory.

2005 (HEDL-TME—77-41) **HEDL magnetic fusion energy programs progress report, January—March 1977.** Doran, D.G. (comp.). May 1977. Contract EY-76-C-14-2170. 35p. Dep. NTIS, PC A03/MF A01.

This report describes progress in four HEDL programs supported by ERDA's Division of Magnetic Fusion Energy. They are (A) Irradiation Effects Analysis, (B) Mechanical Performance of MFE Materials, (C) Preparation and Presentation of Design Data, and (D) Lithium Spill Studies. (A) Results are given on (1) the sensitivity of simulated atomic replacement sequences to the interatomic potential, (2) the status of the program plan under preparation by the Damage Analysis and Fundamental Studies Task Group, and (3) preliminary comparisons of measured helium production at 14 MeV and in a fission spectrum with that calculated from ENDF/B-IV cross sections. (B) A description is given of the development of a thin fatigue specimen for use with light-charged particle irradiations. (C) The current status of the Nuclear Systems Materials Handbook is described; initial distribution has been made of Volume 3 entitled "Materials and Processes: Selection and Control." (D) Preliminary conclusions are given of a lithium hazard literature review. The scope of a program on lithium spill safety is briefly described.

2006 (UCRL—79176) **Experimental laser fusion devices and related vacuum problems.** O'Neal, W.C.; Campbell, D.E.; Glaros, S.S.; Hurley, C.A.; Kobierecki, M.W.; McFann, C.B. Jr.; Monjes, J.A.; Patton, H.G.; Rienecker, F. Jr. 15 Aug 1977. Contract W-7405-ENG-48. 19p. (CONF-770908—7). Dep. NTIS, PC A02/MF A01.

From 7. international Vac. congress and 3. international conference on solid surfaces; Vienna, Austria (12 Sep 1977).

Laser fusion experiments require hard vacuum in the laser-beam spatial filters, target chambers and for target diagnostics instruments. Laser focusing lenses and windows, and target alignment windows must hold vacuum without optical distortion, and must be protected from target debris. The vacuum must be sufficient to prevent residual gas breakdown in focused laser light, avoid arcing at high voltage terminals, minimize contamination and melting of cryogenic targets, and prevent adsorption of the target's microfusion radiation before it reaches the diagnostics instruments.

2007 **Fast-neutron sputtering of niobium.** Harling, O.K.; Thomas, M.T.; Brodzinski, R.L.; Rancitelli, L.A. (Battelle Pacific Northwest Laboratories, Richland, Washington 99352). **48**: No. 10, 4315-4327(Oct 1977).

Neutron sputtering yield measurements of niobium are reported for 14.8-MeV (d,t) neutrons and for fast neutrons in the forward direction produced by 40-MeV deuteron bombardment of a thick Be

target. Six irradiations were performed with 23 niobium targets with a range of 1.7 x 10^{15} to 6.1 x 10^{16} (d,t) neutrons. One irradiation was performed with five niobium targets irradiated with a range of 4.7 x 10^{16} to 4.5 x 10^{17} (d,Be) neutrons. Sputtering targets included single crystals and annealed and cold-worked material with various surface preparations. Target preparation overlapped or was identical, in several cases, to that used by another research group which has reported the observation of fast-neutron-induced "chunk" or micrometer particle emission. Several cm^2 of collector which faced Nb targets irradiated to fluences of (0.4—1.1) x 10^{16} (d,t) neutrons/cm^2 were carefully examined by scanning electron microscopy, but no evidence for neutron-produced chunk emission > or =0.5 μm was found. Thermal neutron activation analysis was used to determine absolute yield on most of the silicon collectors which faced the front and back surfaces of the Nb targets. These determinations indicate that the yield in atoms/neutron for a wide variety of Nb target preparations, including those which are reputed to be high-probability chunk emitters, are likely to be less than several times 10^{-5}. The experimental procedures are presented in detail. The present results for fast-neutron sputtering yields are discussed in relation to other recent results for niobium and theoretical estimates. Limitations in our experiments and others are also discussed. The present results, as well as other recent results for niobium, indicate that neutron sputtering will not be a significant factor in the erosion of the first wall or in plasma contamination in future fusion reactors.

2008 Fusion-neutron-induced nuclear recoil emission probabilities. Harling, O.K.; Thomas, M.T.; Brodzinski, R.L.; Rancitelli, L.A. (Pacific Northwest Laboratory of the Battelle Memorial Institute, Richland, Washington 99352). **48**: No. 10, 4328-4336(Oct 1977).

High-energy neutrons such as those from the (d,t) reaction are capable of producing radioactive recoil particles which can be ejected from the surfaces of irradiated materials. We have made extensive measurements of such recoil emission probabilities with 14.8-MeV (d,t) neutrons and some measurements with a 40-MeV (d,Be) neutrons source. Recoil emission ratios are reported for targets of Nb, Mo, V, 316 SS, Fe, Ni, Cr, Ti, and Au which include 23 different fast-neutron-induced reactions. The total radioactive recoil sputtering ratio for each target range in magnitude from 3 x 10^{-8} to 3 x 10^{-7} recoil atoms/neutron for forward sputtering. Effective recoil atom ranges have been obtained from the experimental data and these are compared with theoretically calculated ranges. Various metallurgical preparations were used for the targets. Some implications of this radioactive recoil sputtering, regular neutron sputtering, and chemical corrosion to future controlled fusion machines are discussed. Neutron ejection of radioactive wall atoms is identified as being of potentially major significance in the operation and maintenance of future fusion reactors.

2009 Large-capacity cryogenic pumping of D_2 and H_2 for fusion. Halama, H.J.; Lam, C.K.; Bamberger, J.A. (Brookhaven National Laboratory, Upton, New York 11973). **14**: No. 5, 1201-1204(Sep 1977).

We have investigated the pumping speed as well as the liquid helium and liquid nitrogen consumption of a large-capacity, all aluminum cryocondensation pump having a projected area of 0.9 m^2 and real area of 1.15 m^2. The liquid-helium-cooled surface was shielded from room-temperature thermal radiation by a black anodized aluminum chevron baffle held at 77 K. Deuterium pumping speed was nearly constant ~80 000 l/s for gas flow rates up to 11 Torr l/s (1.47 Pa m^3/s) and surface coverages up to 9 x 10^{20} molecules/cm^2. The speed, however, increased slightly with coverage. Hydrogen pumping speed was also constant, i.e., 110 000 l/s. The boil off of liquid helium depended on the residual pressure and gas composition in the system. At low pressures boil off of liquid helium for D_2 and H_2 films was 0.53 and 0.85 W, respectively. Boil off of liquid helium increased linearly with the pumped gas load. The liquid nitrogen consumption was only weakly dependent on the pressure in the system.

2010 Role of simulation in the fusion reactor materials program. Reuther, T.C. Jr. (Energy Research and Development Administration, Washington, DC). **26**: 187(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

2011 Use of fission reactors for fusion reactor first-wall studies. Horak, J.A.; Swanks, J.H. (Oak Ridge National Lab., TN). **26**: 187-188(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

2012 Unique role of HFIR in fusion reactor materials evaluation. Maziasz, P.J.; Wiffen, F.W. (Oak Ridge National Lab., TN). **26**: 189-190(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

2013 Application of dual-ion irradiations to fusion materials problems. Nolfi, F.V. Jr.; Taylor, A.; Potter, D.I.; Agarwal, S.C.; Hall, B.O. (Argonne National Lab., IL). **26**: 190(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

2014 Radioactivity calculations in fusion reactors. Sung, T.Y. Madison, WI; Univ. of Wisconsin (1976). 158p. University Microfilms Order No. 77-8817.

Thesis (Ph. D.).

The concept of creating the radioactive decay chains using DCDLIB has been developed at the University of Wisconsin and implemented in activity calculation program DKR. The transmutations of nuclides in a system are treated as linear decay chains and solved using a recursion coefficient formula to get an inventory of nuclides. DKR, written in FORTRAN-IV, is designed to construct and solve the chains using nuclear data from DCDLIB to get the activities; i.e., radioactivity, afterheat, biological hazard potential (BHP), and dose rate in a fusion reactor for one dimensional geometry. The activities of fusion reactors are illustrated for UWMAK-I and Gas-Carried Li_2O Blanket, and activity calculations for the Tokamak Engineering Test Reactor (TETR) are discussed in detail and compared with previous work.

2015 Vacuum container for plasma apparatus. Yamada, M. (to Mitsubishi Atomic Power Industries, Inc., Tokyo (Japan)). Japanese Patent 1976-91,496/A/. 10 Feb 1975. 4p. (In Japanese).

Object: To construct a coil protection tube with a plurality of protection tube elements supported in a spaced-apart relation with respect to the vessel and flexible connection tubes of high electric resistance connecting the adjacent protection tube elements, thereby reducing the induction current without producing excessive stress in the vacuum container and coil conductor. Structure: A coil protection tube is constructed with a plurality of protection tube elements connected together by flexible connection tubes of high electric resistance. The coil of a magnetic limiter coil is supported by a coil protection tube for a low induction current resulting from plasma or the like to prevent deformation of and damage to the coil. Further, each protection tube element is supported by a support means coupled to the outer structure such that it penetrates the container wall with a gap provided with respect to the vacuum container, thereby preventing generation of thermal stress due to thermal expansion between the magnetic limiter and vacuum container.

2016 Vacuum problems associated with the conceptional design of tokamak fusion reactors. Lewin, G.; Tenney, F.H. (Princeton Univ, N.J. (USA). Plasma Physics Lab.). No. Suppl. 2-1, 221-224(1974).

From 6. international vacuum congress; Kyoto, Japan (25 Mar 1974).

The design and operation of D-T fusion reactors based on the tokamak configuration is described with special emphasis on the vacuum aspects. Particular reference is made to the reactor study of the Princeton Plasma Physics Laboratory. Vacuum requirements of two other reactor studies based on the theta pinch and the mirror configuration are briefly mentioned. Problems arising from the radioactivity of the tritium and the high, locally variant temperatures are discussed.

2017 Some considerations on large-sized catalytic pumps for nuclear fusion apparatus. Murakami, Y. (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan). Research and Development Center); Kurisaki, T.; Ishibe, Y.; Okamoto, K. No. Suppl. 2-1, 89-92(1974).

From 6. international vacuum congress; Kyoto, Japan (25 Mar 1974).

Studies have been made of the problems encountered in the development of a large-sized catalytic pump for the pumping of hydrogen in nuclear fusion apparatus. An experimental pump having a speed of about 5000 liter/sec is assumed to use at partial pressures between 10^{-7} and 10^{-5}Torr. The influence of water vapor on the atomization of hydrogen at the rhenium filament is one of the problems, and is discussed from the structural point of view. The lifetime of the cuprous oxide layer is another important problem. A convenient method of oxidation of copper plates by atomic oxygen produced at an incandescent rhenium filament is proposed for the generation and regeneration of the oxide. The optimum temperatures of the cuprous oxide layer are also determined for the rapid desorption of water vapor from the oxide and for the effective reaction with hydrogen atoms.

GENERAL AND MISCELLANEOUS

MANAGEMENT

REFER ALSO TO CITATION(S) 990, 1565

MATHEMATICS AND COMPUTERS

REFER ALSO TO CITATION(S) 1747

2018 (K/CSD/TM—12) **REGPLOT: a plotting program to graphically check HEATING5 input data.** Elrod, D.C. Aug 1977. Contract W-7405-ENG-26. 70p. Dep. NTIS, PC A04/MF A01.

The plotting program, REGPLOT, was written to allow users of HEATING5, a generalized heat conduction code, to graphically check their HEATING5 input data. REGPLOT reads HEATING5 input data and plot specification data for one-, two-, and three-dimensional models. The program then creates maps of the regions, the materials, the heat generation function numbers, the initial condition function numbers, and the boundary condition function numbers by drawing the region boundaries and labeling each region appropriately. The user can then check his modeling data visually. The plot specification data allow the user to input the planes that are to be plotted if the model is three-dimensional, the type of map that is to be created, the area of the plane that is to be drawn, and the scaling factors that are to be used. Default values will be used if the area of the plane to be drawn and the scaling factors are not specified. The REGPLOT program is operational in the batch mode on the IBM 360/370 computer systems, and in the timesharing mode on the DEC PDP-10 system accessed by a graphics terminal. 19 figures, 3 tables.

2019 (LA-UR—77-1931) **Portable graphics.** George, J.E. 1977. Contract W-7405-ENG-36. 9p. (CONF-770845—1). Dep. NTIS, PC A02/MF A01.

From 10. computer science and statistics) annual symposium on the interface; Washington, District of Columbia, USA (Aug 1977).

The portability of graphics software is discussed for the past, present, and future. Early methods of portability are examined and contrasted with modern methods; the effects of the current graphic standards effort are surveyed. Representative portable graphic systems are discussed, and sample applications are utilized for illustration. 4 figures.

2020 (SLAC-PUB—1566) **Data structures for pattern recognition algorithms: a case study.** Zahn, C.T. Jr. Mar 1975. 5p. (CONF-7505143—1). Dep. NTIS, PC A02/MF A01.

From Conference on computer graphics, pattern recognition, and data structure; Los Angeles, California, USA (14 May 1975).

Experiences gained while programming several pattern recognition algorithms in the languages ALGOL, FORTRAN, PL/1, and PASCAL are described. The algorithms discussed are for boundary encodings of two-dimensional binary pictures, calculating and exploring the minimum spanning tree for a set of points, recognizing dotted curves from a set of planar points, and performing a template matching in the presence of severe noise distortions. The lesson seems to be that pattern recognition algorithms require a range of data structuring capabilities for their implementation, in particular, arrays, graphs, and lists. The languages PL/1 and PASCAL have facilities to accomodate graphs and lists, but there are important differences for the programmer. The ease with which the template matching program was written, debugged, and modified during a 3 week period, by using PASCAL, suggests that this small but powerful language should not be overlooked by those researchers who need a quick, reliable, and efficient implementation of a pattern recognition algorithm requiring graphs, lists, and arrays. 5 figures.

2021 (UCID—17524(Rev.1)) **Microcomputer standardization program at Lawrence Livermore Laboratory.** Stripeika, A.J. 8 Aug 1977. Contract W-7405-ENG-48. 18p. Dep. NTIS, PC A02/MF A01.

The history and development of transistorized computers and microcomputers in the context of LLL is recounted. The following sorts of microcomputer standardization support are available: small computer users library, software licensing agreements, LSI-11 bulletin, EE bulletin, users meetings, stores stock and documentation, publications, educational facilities, hardware designs, memory programing center, simulators, and application assistance. 6 figures. (RWR)

2022 **Extension of Jentzsch's theorem to nonlinear Hammerstein operators.** Leggett, R.W. (Oak Ridge National Lab., TN); Williams, L.R. **60**: No. 1, 248-254(Aug 1977).

A classical theorem of Jentzsch [J. Reine Angew. Math. 141, 235-44 (1912)] states that the Fredholm linear integral operator Ax(t) = integral K(t,s) x (s)ds, with continuous kernel K: [a,b] x [a,b] → (0, integral), has a positive eigenvalue lambda corresponding to a positive eigenfunction x: [a,b] → R. Of particular interest is an important nonlinear analog of the above, the Hammerstein integral operator Ax(t) = integral K(t,s)f(s,x(s))ds. Here K is nonnegative and the nonlinearity f is continuous and nonnegative on [a,b] x [0,c) for some c greater than 0. Also, f(s,0) is identically 0, so that the zero function is an eigenvector of A. It is of interest to find conditions on K and f under which A has positive eigenpairs, that is, a positive eigenvalue lambda corresponding to a nonnegative eigenfunction x which is not identically zero. This article proves the existence of positive eigenpairs for the Hammerstein integral operator for an extensive class of locally positive kernels which satisfy a weak uniformity condition, with no growth restrictions whatever on f. In fact, all that is assumed is that f is positive on certain subsets of [a,b] x (0, infinity). The class of kernels considered here includes and is far less restrictive than the class of kernels of Jentzsch's theorem. (RWR)

2023 **Mixed-hybrid finite element approximations of second-order elliptic boundary-value problems.** Babuska, I.; Oden, J.T.; Lee, J.K. (Univ. of Maryland, College Park). **11**: No. 2, 175-206(May 1977).

Mixed-hybrid finite element approximations are described for second-order elliptic boundary-value problems in which independent approximations are used for the solution and its gradient on the interior of an element and the trace of the gradients on the boundary of the element. A priori error estimates are derived with conditions for convergence. Several other finite element models are also obtained as special cases. Some numerical examples are included.

2024 **Modeling and simulation. Volume 7, Part 1.** Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976). 722p. (CONF-760435—P1). .

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

Topics covered included modeling and simulation applied to computers; mine power systems; error coding; statistics and probability; communications; control; information and data processing; process industries; transportation; languages; aeronautics; electronic circuits; energy systems; chemistry; environment; and industry. In Part 1, eighteen items were selected for Energy Research Abstracts (ERA) and four for Energy Abstracts for Policy Analysis (EAPA).

2025 **Modeling and simulation. Volume 7, Part 2.** Vogt, W.G.; Mickle, M.H. (eds.). Pittsburgh; Instrument Society of America (1976). 652p. (CONF-760435—P2). .

From 7. annual conference on modeling and simulation; Pittsburgh, Pennsylvania, United States of America (USA) (26 Apr 1976).

Topics covered included modeling and simulation applied to economics; social systems; regional analysis; urban planning; energy systems; structures; design; education; biology; and medicine. In Part 2, thirty-five items were selected for Energy Research Abstracts (ERA), with twenty-four going into Energy Abstracts for Policy Analysis (EAPA). Four items had been processed previously.

2026 **Digital image processing of simulated turbulence and photon noise degraded images of extended objects.** Breedlove, J.R. Jr. (Los Alamos Scientific Lab., NM). pp 155-162 of In Imaging through the atmosphere. Vol. 75. Palos Verdes, CA; Society of Photo-Optical Instrumentation Engineers (1976).

Conventional post-detection image processing techniques were applied to three simulations of photon-noise-limited images of the moon which might be obtained through atmospheric turbulence. This study demonstrates that homomorphic filtering, parametric Wiener filtering, and constrained least-squares filtering can produce nearly diffraction-limited imagery if the atmosphere is "frozen" for 1/100—1/10 s. 6 figures.

INFORMATION HANDLING

REFER ALSO TO CITATION(S) 951, 1026

2027 (CONF-7608109—1) **Information analysis center concept: products, services, and pricing policies.** Gerstner, H.B.; Huff, J.E.; Ulrikson, G.U. 1976. Contract W-7405-ENG-26. 25p. Dep. NTIS, PC A02/MF A01.

From Conference on technology, management, and economics of information centers and services; Easton, Maryland, USA (29 Aug 1976).

The steadily increasing literature volume in all fields of science and technology has created a need for specialized information centers. The Information Center Complex, a major scientific and

technical unit within the Information Division, was established at the Oak Ridge National Laboratory in mid-1970 to bring together for mutual benefit several information activities. One of these, the Toxicology Information Response Center (TIRC), was founded in 1971 by the Toxicology Information Program/National Library of Medicine to establish a national and international center for toxicology information. As an information analysis center, TIRC selects, evaluates, and synthesizes comprehensive literature packages according to a user's specific request or to satisfy current needs (chlordecone, vinyl chloride, trichloroethylene). TIRC also prepares and publishes specialized bibliographies, state-of-the-knowledge overviews, and state-of-the-art reviews on topics of current concern. TIRC interacts with a large and diverse user population: government agencies, industry, academia, private citizens, and other organizations—both domestic and foreign. Toxicology information is no exception to the generally accepted axiom that most published literature—even that reporting on a single, well-defined subject area—appears scattered throughout the world in myriad sources. Secondary sources allow the user to cope more adequately with the burgeoning and elusive literature. The presentation begins by detailing the overall Information Center Complex organization, moves to the Biomedical Sciences Section, and then centers on the Toxicology Information Response Center describing functional activities as well as the economics involved in operating an information analysis center.

CORPORATE INDEX

In the corporate index, report literature is indexed using the name of the organization or institution responsible for issuing the report. Headings are provided for all report literature and for published literature for which a corporate approach is especially desirable, e.g., symposium and conference proceedings.

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Title, (supplementary information), citation number, (report number)

The title may be supplemented with additional words, or a phrase, if it appears additional information would be helpful. In cases for which the title contains little or no information related to the subject entry, it may be replaced entirely by the supplementary information. A qualifier is not always required, and in such cases the title will follow the unqualified subject descriptor.

The descriptors selected for use as subject terms are generally the names of specific materials, things, or processes. To the extent possible, a qualifier is selected to describe the properties of, or processses applied to, the subject term.

Index entries are selected to indicate the important ideas and concepts presented in a document, rather than words that may appear in the text. Within the available thesaurus terms, the most probable or logical place to look for typical information is selected. "See references" are included to guide users from synonymous terms or phrases to the descriptor selected as a subject heading for the concept. (e.g. Pipeline Quality Gas see HIGH BTU GAS). "See also references" are used to indicate where to find references to subject concepts that are narrower, broader, or related to a particular subject heading. To complete an exhaustive search of a given subject, all such headings should be reviewed.

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CONF-7610127-		(American Public Power Association Services and Communications Section workshop, San Francisco, California, USA, 20 Oct 1976)
1	3:995	Applied Nucleonics Company, Inc. (1976).
CONF-761102-		(A.I.M. meeting, Liege, Belgium, 15-18 Nov 1976)
3	3:1359	*See* BNL-22879
CONF-761153-		(62. annual meeting of radiologic advances in breast cancer, Chicago, Illinois, United States of America (USA), 15 Nov 1976)
4	3:1328	*See* COO-323-37
CONF-761168-		(ERDA/DPR symposium on thin-film research, Pacific Grove, California, United States of America (USA), 1-3 Nov 1976)
1	3:424	Dep. NTIS, PC A02/MF A01
CONF-761178-		(9. annual battery workshop, Greenbelt, Maryland, United States of America (USA), 9-10 Nov 1976)
	3:899	*See* X-711-77-28
CONF-761185-		(57. conference of research workers in animal diseases, Chicago, Illinois, USA, 29-30 Nov 1976)
1	3:1456	*See* COO-910-44
CONF-761235-		(2. workshop on lead-acid batteries for utility application, Washington, District of Columbia, United States of America (USA), 9-10 Dec 1976)
	3:894	*See* EPRI-EM-399-SR
CONF-770121-		(Conference on stable isotopes: applications in pharmacology, toxicology, and clinical research, London, United Kingdom of Great Britain and Northern Ireland (UK), 3-4 Jan 1977)
2	3:1424	Dep. NTIS, PC A03/MF A01
CONF-770130-		(Conference on polycyclic hydrocarbon carcinogenesis, New Orleans, Louisiana, United States of America (USA), 24-27 Jan 1977)
3	3:1526	Dep. NTIS, PC A03/MF A01
CONF-770210-		(A.A. advancement of science conference, Denver, Colorado, United States of America (USA), 20-25 Feb 1977)
10	3:993	University of Wisconsin (1977).

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CONF-770218-		(EPA workshop on environmental criteria development for radioactive waste management, Reston, Virginia, United States of America (USA), 3-5 Feb 1977)
	3:342	*See* ORP/CSD-77-1
CONF-770221-		(EPRI fuel cycle risk assessment workshop, Palo Alto, California, United States of America (USA), 9-11 Feb 1977)
2	3:322	*See* BNWL-SA-6158
CONF-770331-		(4. ocean thermal energy conversion conference, New Orleans, Louisiana, United States of America (USA), 22-24 Mar 1977)
4	3:483	*See* BNWL-SA-6208
CONF-770339-		(International conference in metallurgical coatings, wear erosion session, San Francisco, California, United States of America (USA), 28 Mar-1 Apr 1977)
3	3:1122	*See* BDX-613-1804
CONF-770346-		(Symposium on excited states in organic and biochemistry, Jerusalem, Israel, 28-31 Mar 1977)
2	3:1464	*See* COO-2364-12
CONF-770369-		(NAEG Pu program report meeting, Las Vegas, Nevada, USA, 2-4 Mar 1977)
1	3:1379	*See* UCLA-12-1123
CONF-770401-		(5. international conference on reactor shielding, Knoxville, Tennessee, United States of America (USA), 18-22 Apr 1977)
23	3:1762	*See* UCRL-78560
28	3:759	Dep. NTIS, PC A02/MF A01
29	3:830	Dep. NTIS, PC A02/MF A01
30	3:676	Dep. NTIS, PC A02/MF A01
CONF-770434-		(SPIE x-ray imaging symposium, Reston, Virginia, United States of America (USA), 20-21 Apr 1977)
4	3:1332	*See* SAND-77-8621
CONF-770452-		(Workshop on pion-nucleus scattering, College Park, Maryland, United States of America (USA), 22-23 Apr 1977)
1	3:1745	*See* BNL-22834
CONF-770505-		(International conference on nuclear power and its fuel cycles, Salzburg, Austria, 2-13 May 1977)
233	3:337	*See* ORNL-tr-4390
CONF-770512-		(Symposium on management of low level radioactive waste, Atlanta, Georgia, United States of America (USA), 23-27 May 1977)
18	3:325	*See* LA-UR-77-1294
CONF-770523-		(Symposium on neutron cross sections 10-40 MeV, Upton, New York, United States of America (USA), 3-5 May 1977)
5	3:1747	*See* LA-UR-77-1031
CONF-770537-		(7. symposium on thermophysical properties, Gaithersburg, Maryland, United States of America (USA), 10-12 May 1977)
3	3:1163	Dep. NTIS, PC A02/MF A01
8	3:1125	*See* UCRL-78782
CONF-770539-		(American Wind Energy Association meeting, Boulder, Colorado, United States of America (USA), 13 May 1977)
3	3:558	*See* ERDA/NASA/1004-77/2
CONF-770545-		(British Nuclear Energy Society conference on ferritic steels for fast reactor steam generators, London, United Kingdom of Great Britain and Northern Ireland (UK), 30 May-2 Jun 1977)
2	3:1112	Dep. NTIS, PC A02/MF A01
CONF-770547-		(Solar energy short course, Madrid, Spain, 2-7 May 1977)
1	3:446	*See* SAND-77-0760C
CONF-770561-		(Technical meeting of the Canadian Section of the Combustion Institute, Banff, Canada, 26-27 May 1977)
2	3:96	*See* LBL-6339
CONF-770580-		(Symposium on the history of nuclear physics, Minneapolis, Minnesota, USA, 18-21 May 1977)
1	3:1746	*See* BNL-23062
CONF-770591-		(Joint scientific meeting, Lake Geneva, Wisconsin, USA, 7 May 1977)
1	3:1372	*See* COO-323-38
CONF-770613-		(2. international congress on hydrogen in metals, Paris, France, Jun 1977)
3	3:1147	*See* COO-3459-13
CONF-770620-		(Computational fluid dynamics conference, Albuquerque, New Mexico, United States of America (USA), 3 Jun 1977)
1	3:1227	*See* SAND-77-8502
CONF-770639-		(Workshop on correlation of neutron and charged particle damage, Oak Ridge, Tennessee, United States of America (USA), 8-9 Jun 1977)
1	3:1153	Dep. NTIS, PC A03/MF A01
CONF-770642-		(3. international conference on ion beam analysis, Washington, District of Columbia, United States of America (USA), 27 Jun-1 Jul 1977)
12	3:1343	Dep. NTIS, PC A02/MF A01
CONF-770643-		(32. symposium on molecular spectroscopy, Columbus, Ohio, United States of America (USA), 13-17 Jun 1977)
(Absts.)	3:1607	Ohio State University, Columbus, OH
CONF-770644-		(EPRI review meeting on advanced fuel fusion, Chicago, Illinois, United States of America (USA), 27-28 Jun 1977)
7	3:1963	*See* UCRL-79641
CONF-770649-		(International discussion meeting of radiation effects in superconductors, Argonne, Illinois, United States of America (USA), 13-16 Jun 1977)
3	3:1152	*See* BNL-22925
CONF-770653-		(International conference on multiphoton processes, Rochester, New York, United States of America (USA), 6-9 Jun 1977)
2	3:1608	*See* LBL-6275
CONF-770656-		(Annual meeting of the Institute of Nuclear Materials Management, Washington, District of Columbia, United States of America (USA), 29 Jun-1 Jul 1977)
2	3:347	Dep. NTIS, PC A02/MF A01
23	3:350	*See* SAND-77-8624
CONF-770660-		(IRAP congress, Palaiseau, France, 27 Jun-3 Jul 1977)
1	3:1940	*See* UCRL-79334
CONF-770663-		(Workshop on repair mechanisms and exposure standards, Oak Ridge, Tennessee, USA, 28-30 Jun 1977)
1	3:1471	*See* BNL-23150
CONF-770674-		(Nucleon-nucleon interaction meeting, Vancouver, Canada, 27-30 Jun 1977)
2	3:1686	*See* COO-3001-186
3	3:1744	*See* COO-3069-534
CONF-770677-		(International conference on drugs, hormones, and membranes, Crans-sur-Sierre, Switzerland, 12-17 Jun 1977)
1	3:1425	Dep. NTIS, PC A02/MF A01
CONF-770706-		(6. AIRAPT international high-pressure conference, Boulder, Colorado, United States of America (USA), 25-29 Jul 1977)
2	3:1118	*See* UCRL-79012
20	3:1562	*See* UCRL-79058
CONF-770713-		(3. international conference on laser spectroscopy, Jackson Hole, Wyoming, United States of America (USA), 4-8 Jul 1977)
2	3:1609	*See* UCRL-79550
CONF-770716-		(Meeting on sensor technology for battlefield and physical security applications, Fort Belvoir, Virginia, United States of America (USA), 13-15 Jul 1977)
1	3:349	*See* SAND-77-0502C
CONF-770718-		(Symposium on actions of physical and chemical mutagens on the somatic chromosomes of man, Edinburgh, United Kingdom of Great Britain and Northern Ireland (UK), 7-8 Jul 1977)
2	3:1465	*See* UCRL-79664
4	3:1463	Dep. NTIS, PC A02/MF A01
CONF-770721-		(3. international symposium on plasma chemistry, Limoges, France, 13-19 Jul 1977)
1	3:1853	Dep. NTIS, PC A02/MF A03
CONF-770725-		(11. international symposium on shock tubes and waves, Seattle, Washington, USA, 11-14 Jul 1977)
1	3:1833	Dep. NTIS, PC A02/MF A01
CONF-770726-		(6. workshop on personnel neutron dosimetry, Oak Ridge, Tennessee, USA, 11-12 Jul 1977)
3	3:1336	*See* UCRL-79633

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CONF-770730-		(Symposium on statistical ecology, College Station, Texas, USA, 25-29 Jul 1977)
1	3:1377	Dep. NTIS, PC A03/MF A01
CONF-770731-		(Symposium on trace element metabolism in man and animals, Freising-Weihenstephan, F.R. Germany, 25-29 Jul 1977)
1	3:1449	*See* BNL-23037
CONF-770801-		(Cryogenic engineering conference, Boulder, Colorado, United States of America (USA), 2-5 Aug 1977)
6	3:1174	*See* UCRL-79036(Rev.1)
17	3:1978	Dep. NTIS, PC A02/MF A01
19	3:1997	*See* LA-UR-77-1523
CONF-770804-		(12. intersociety energy conversion engineering conference, Washington, District of Columbia, United States of America (USA), 28 Aug-2 Sep 1977)
7	3:1057	*See* BNL-22820
CONF-770807-		(4. international conference on structural mechanics in reactor technology, San Francisco, California, United States of America (USA), 15-19 Aug 1977)
24	3:841	Dep. NTIS, PC A02/MF A01
26	3:1113	Dep. NTIS, PC A02/MF A01
27	3:677	Dep. NTIS, PC A02/MF A01
CONF-770808-		(15. international Cosmic Ray Conference, Provdiv, Bulgaria, 13-26 Aug 1977)
2	3:1578	*See* LA-UR-77-1055
CONF-770814-		(American Chemical Society meeting, Chicago, Illinois, United States of America (USA), 29 Aug-2 Sep 1977)
2	3:1225	*See* DP-MS-77-21
CONF-770823-		(International symposium on hydrides for energy storage, Geilo, Norway, 14-19 Aug 1977)
2	3:372	*See* BNL-23046
CONF-770836-		(Symposium on enhanced oil and gas recovery, Tulsa, Oklahoma, USA, 30 Aug-1 Sep 1977)
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CONF-770839-		(Symposium on protein turnover and lysosomal function, Buffalo, New York, USA, 21-26 Aug 1977)
1	3:1426	Dep. NTIS, PC A03/MF A01
CONF-770841-		(Workshop on probability density function methods for turbulent flows, Aachen, F.R. Germany, 29 Aug-2 Sep 1977)
1	3:1633	*See* BNL-23147
CONF-770842-		(6. international conference on magnet technology, Bratislava, Czechoslovakia, 29 Aug-2 Sep 1977)
1	3:1982	*See* UCRL-78891
4	3:1979	Dep. NTIS, PC A02/MF A01
5	3:1980	Dep. NTIS, PC A02/MF A01
7	3:1981	*See* UCRL-78890
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3	3:1314	*See* LA-UR-77-1790
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1	3:2019	*See* LA-UR-77-1931
CONF-770847-		(15. international thermal conductivity conference, Ottawa, Ontario, Canada, 24-26 Aug 1977)
1	3:532	*See* SAND-77-1035
CONF-770906-		(8. European conference on controlled fusion and plasma physics, Prague, Czechoslovakia, 19-23 Sep 1977)
3	3:1865	*See* LA-UR-77-1050
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4	3:2004	Dep. NTIS, PC A02/MF A01
7	3:2006	*See* UCRL-79176
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1	3:506	*See* LA-UR-77-1517
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2	3:554	*See* UCRL-79896
CONF-771006-		(Workshop on future computer requirements for computational aerodynamics, Moffett Field, California, USA, 4-6 Oct 1977)
1	3:1306	*See* SAND-77-1004C
CONF-771010-		(Conference on environmental degradation of engineering materials, Blacksburg, Virginia, USA, 10-13 Oct 1977)
1	3:1148	*See* DP-MS-77-46
CONF-771019-		(International microelectronics symposium, Baltimore, Maryland, USA, 24-26 Oct 1977)
1	3:1124	*See* SAND-77-0137C
CONF-771020-		(23. technical conference of the cellular plastics division, San Francisco, California, USA, 26 Oct 1977)
1	3:1173	*See* SAND-77-1159C
CONF-771102-		(20. annual AICHE meeting, New York, New York, USA, 13-17 Nov 1977)
2	3:1360	*See* BNL-23063
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AT Liquid Metal Fast Breeder Reactor applied technology is available to domestic requesters within the United States from the Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37830.
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Issue 4

October 1977

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